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Mental Health PROGRAM REPORTS-4

National Institute of Mental Health

MENTAL HEALTH PROGRAM REPORTS – 4
January 1970

Prepared by:

Program Analysis and Evaluation Branch
Office of Program Planning and Evaluation

National Institute of Mental Health
Chevy Chase, Maryland 20015

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Coordination and preparation of the *Program Reports* series are under the direction of Dr. Julius Segal as part of the activities of the Institute's Program Analysis and Evaluation Branch. As always, the reader's comments and suggestions are welcome.

STANLEY F. YOLLES, M.D.,
Director,
National Institute of Mental Health.

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BIOLOGICAL BASES OF MEMORY

Investigator: JAMES L. McGAUGH, Ph. D.
University of California
Irvine, Calif.
Prepared by: GAY LUCE

Introduction

The survival of mankind may now hang upon how well we can educate each coming generation, since the capacity for sophisticated and cooperative behavior has become the essential of modern civilization. Ironically, our educational institutions lag behind us. Agriculture and medicine have been transformed by modern scientific research while the schools remain virtually untouched by the 20th century. One aspect of the scientific harvest that might indeed influence the training of the young is the exploration of biological bases for learning and memory. We can no longer afford the luxury of ignoring important problems of memory and their implications for the manner in which we teach.

The social implications of some researches in this area are just beginning to be known. Experiments with rats have divulged a genetic base for learning. As University of California Professors Krech and Rosenzweig and their associates have demonstrated, it is possible to influence the learning ability of rodents by enriching or impoverishing the environment, thereby also altering brain biochemistry. Without stimulation, there can be little learning. Without memory, there can be no learning. There appear to be many processes in memory, some related to short-term memory, some related to long-term storage, and others related to retrieval. There are some patients with brain damage, for example, who appear to be normal, with unaffected IQ's, yet they cannot learn anything new, not even a new home address. Dr. McGaugh and his associates have used electroconvulsive shock to produce a similar amnesia for new experience in animals. By this device he has seen evidence that there may be two separate stages in the implantation of any memory.

The potentiality for improving education by using such research has been demonstrated by Prof. Millard Madsen of UCLA. He has shown how knowledgeable timing of information will permit children with low IQ scores to learn quite as well and almost as fast as children with high IQ's.

In studying biochemical influences upon memory, Doctor McGaugh has recently found that biological time of day may also influence learning behavior.

History

In 1917, the psychologist William Lashley observed that rats would learn to run a maze with more celerity than usual if they were first given low doses of strychnine sulfate. The implication that drugs might influence learning or be useful in exploring memory processes was ignored for several decades. Then, stimulant drugs, known as analeptics, were again observed to facilitate learning.

In recent experiments strychnine, picrotoxin, pentylenetetrazole, and diazadamantanol have been used on animals performing prescribed and measurable tasks. Some have been discrimination problems, in which the animals learned to choose among alternative paths in a maze in order to reach a goal and to discriminate between black and white gates, while in others they had to escape from a situation in which they would be punished or learn restraint in order to avoid electric shock. The situations, while limited, were precisely controlled and therefore quantifiable. In most of the early studies, animals were first given stimulants a few minutes before their first encounter with the training, and were trained under drug influence. Did the drug influence the process we call memory? Perhaps not. Perhaps it improved performance by making the animal more attentive, by sharpening his perceptions, by enhancing his motivation, or by improving muscular coordination. Research on learning resembles the divergent reports from six blind men describing an elephant, each touching a different part of the beast. The impact of a drug upon "learning" is partly dependent upon the measure of learning. One easily quantified part of performance is the response latency—how long it takes the animal to get around to making a response. When this measure is the criterion of learning, a drug that increases response speed or alertness will also seem to improve learning. Since no experimenter can afford to use many criteria of performance, studies of learning and memory typically contain some knotty problems of method and measurement. Doctor McGaugh and his associates began to train undrugged animals, but gave them "memory" tests while they were drugged. Perhaps drugs altered dimensions of performance, although they did not act upon memory processes during learning. It soon appeared that the memory process, itself, was exceedingly subtle.

Retrograde Amnesia

One means of exploring memory is by training a creature on a narrowly prescribed performance and administering drugs or convulsive shock at intervals directly after the training. Will they interfere with the consolidation of memory? Does it matter how soon after training the shock or drug is given? In the course of many such experiments, the grantee and his associates found that animals shocked immediately, or at short intervals after training, seemed later not to recall. By strategically varying their treatment of the animals, they saw that training or experience seemed to initiate a kind of potential residue for memory. Yet this potentially permanent memory would remain labile for long periods, perhaps hours, before being permanently etched into the neural code of memory. These studies in which memory was impaired by drug or shock interference led Dr. McGaugh to wonder about enhancing memory in a similar manner. If there is a long period after training in which memory processes are active, a memory-enhancing drug could be given in this interval after training and should improve performance or make the animal resistant to calculated amnesia-electroshock.

Drugs After Training

The training procedures were straightforward. Animals were conditioned to push a lever or avoid a grid, etc. Then, after training, they were injected with drugs. After a suitable interval allowing the drugs to be metabolized, the animals were tested on the original procedure. A number of drugs appeared to enhance performance when injected after training—and by implication seemed to be acting upon the mysterious processes of memory. Strychnine, picrotoxin (at low doses), and amphetamine all seemed to enhance the learning of animals who received doses directly after training: on tests they outperformed the animals who had received only a placebo.

During the last few years, several drugs have been given to animals on a wide range of learning tasks, measured by various criteria. Clearly, the outcome is some blend of the kind of learning (it is vastly different to learn to discriminate between two colors than to learn to avoid a shock at the toll of a bell), the experimental conditions, the drug, and the amount of the drug used. Results from laboratories around the country are not all in accordance, but most of the evidence suggests that certain drugs enhance learning. If so, presumably, they are acting upon memory storage in its labile period. Presumably, these same drugs would do nothing for memory if they were injected at some maximum time after training. By carefully graded experiments, therefore, one might expect to delineate how long the labile period of memory lasts.

The procedure in this laboratory was straightforward. One group of animals would be injected with a drug 5 seconds after they responded to a learning procedure. Another group would be injected after 1 minute, still another after 5 minutes, and so on. During 1962, Doctor McGaugh was injecting strychnine at various intervals after training: he found that one strain of mice "learned" better if injected immediately after training, yet injections given a half hour after training were ineffective. On a discrimination task, one group of mice showed the greatest facilitation—by comparison with undrugged controls—if they were injected between 5 and 15 minutes *before* training.

> The results of these studies of effects of time of administration of drugs indicate that the effects are time-dependent. The magnitude of the facilitating effect decreases with the interval between training and drug administration. These findings are consistent with the studies of experimentally induced retrograde amnesia. Together, these two lines of evidence provide very strong support for the view that memory storage processes are susceptible to both facilitating and impairing influences for a relatively long period of time following training.

Environment

The elusiveness and delicacy of the process of memory—and the sensitivity of rodents—has forced the investigators to take all kinds of precautions against slamming doors and disturbance in the laboratory. The need for constant temperature, quiet, etc., was underscored by an experiment in which mice, given strychnine, were given a discrimination problem and were disrupted by environmental stimulation. Like students trying to memorize a lesson in an "acid-rock" discotheque under strobe lights, half these mice were rocked back and forth in their cage, exposed to flashing lights and bursts of sound for 20 minutes. On tests, it was the other half of the animals—those who remained in dark quiet cages—who showed enhanced learning from strychnine while the stimulated animals did worse than controls. It was an encouragement for control in the learning laboratory and perhaps also a hint for humans.

Drug Attenuation of Retrograde Amnesia

Inevitably, the investigators wondered whether strychnine and other drugs enhanced learning by accelerating the rate at which memory traces were consolidated into permanent memory. If so, the drugs should prevent or attenuate the kind of retrograde amnesia that is caused by convulsive shock. Animals were given saline solution or strychnine just before or just after training: then, within a few minutes each animal was shocked. A day later each mouse was tested on

the training task. The drug-injected animals did a little better on tests than did the controls who received only saline solution. It appeared that drugs attenuated the amnesia, but the reason was not clear.

Recently, the experimenters have used a different kind of task, one on which a single exposure is sufficient for a test of learning. It is known as a "one trial inhibitory test."

Each mouse is placed on a small cantilevered platform on the outside wall of a box. There is an entry hole leading to the dark interior. The mouse is a nocturnal animal. In his search for comfort and security he will soon step inside the hole. Most mice hesitate for no more than 10 seconds. Their predicament resembles that of a human being, stuck in the dead of night on a small porch without rails, hundreds of feet above ground on a skyscraper, with an open window leading to a well-lit room. What person would not try to enter that room?

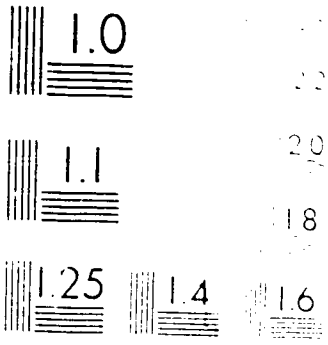
The mouse, seeking the comfort and security of a dark box, would step in the hole and immediately get a shock on the foot. Twenty-four hours later he would be placed on the platform again. Would he remember that the hole leads to a "forbidden" place? Would he restrain his natural urge for security? The length of time that he would hesitate on the platform before attempting to enter the box would represent a degree of learning. This time, resisting temptation, as it were, was measured as the criterion of learning.

Each mouse was placed on the platform, received a footshock when it transgressed the boundary and then received electroconvulsive shock. For some, the shock came within 18 seconds; for some, it came after 18 seconds: and other animals received it an hour or 3 hours later. Some of these mice were on saline solution, whereas half the mice received strychnine either 10 minutes before or a minute after the platform training.

Twenty-four hours later, each mouse was put to the test, placed on the platform, and clocked. The amount of time an animal stayed on the platform without moving through the hole was directly proportional to the amount of time he had been allowed between his first experience and electroconvulsive shock. The animals given shock 3 hours after training showed no amnesia at all. Control animals given shock 18 seconds or a minute after their training experience seemed to have forgotten that entry was forbidden. Those pretested with strychnine were not rendered so completely amnesic by shock at the same short intervals. Oddly enough, some memory also persisted in the animals who had injections of strychnine *after the electroshock*.

> If strychnine affects learning by accelerating consolidation processes, these injections should have no effect. However, as can be seen, retention of these animals was superior to that of controls.

Why should strychnine counteract the amnesia effects when injected *after* electroshock?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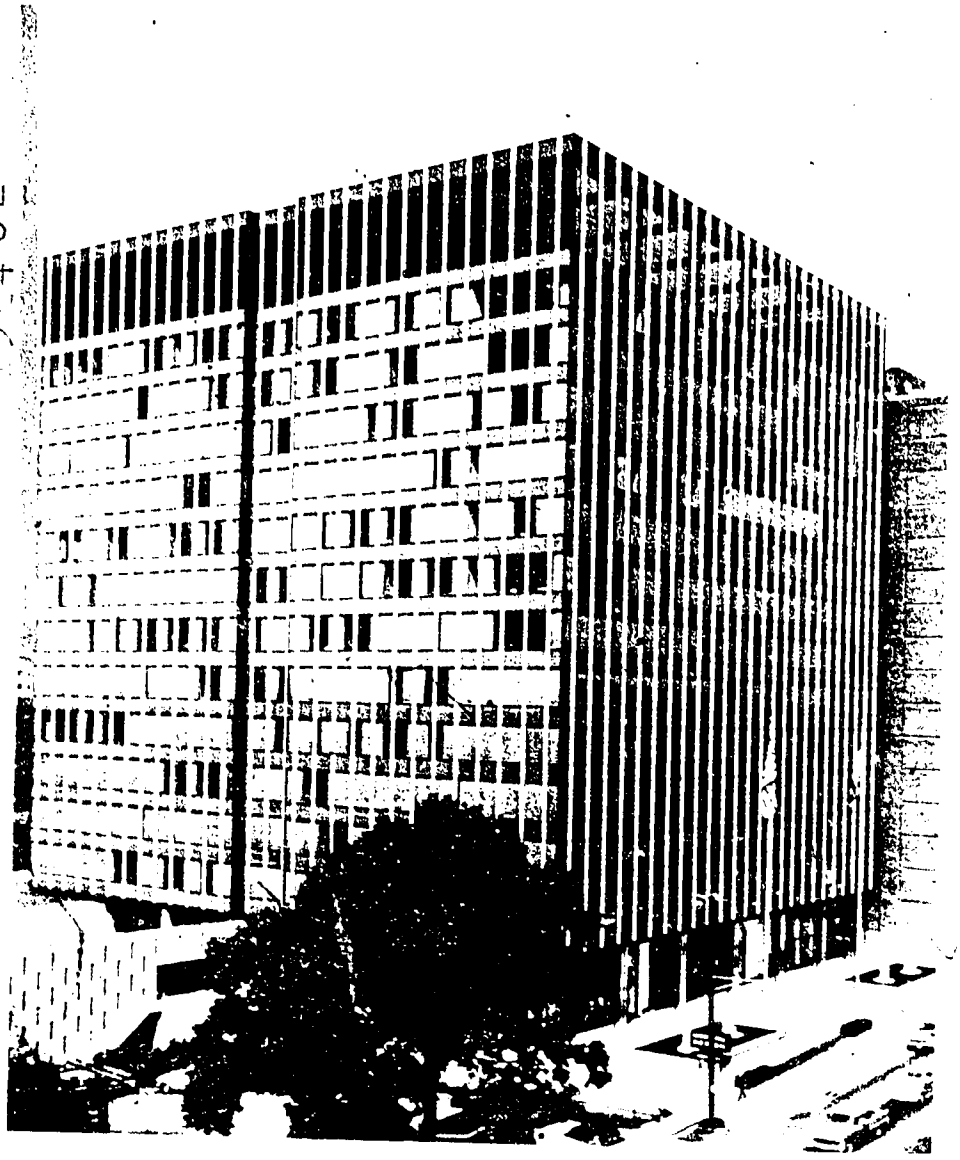

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Why should strychnine counteract the amnesia effects when injected *after* electroshock?

[illegible] inmates have developed courses in personal [illegible] speech, improving the memory, orienta [illegible] other subjects. One man who was studying [illegible] for a half-year course in welding just [illegible] theory of it. The course in technical [illegible] dropped after a few years because employers [illegible] but the welding lessons, like [illegible] by inmates, have become part of [illegible]

[illegible] production of P.I. materials has boomed [illegible] of courses are available. The problem [illegible] courses but to select from the [illegible] One new program, though, is definitely [illegible] aid of offenders—in particular, [illegible] and it will teach *how to succeed*

Reinforcement

[illegible] instruction has its own built-in reinforce- [illegible] gets from finding that an answer is correct (or, if it [illegible] from learning what was wrong and from being encour- [illegible] the staff at Draper found that the typical inmate [illegible] after a few weeks. So it has employed a number of tangible [illegible] motivating environment. For instance, students who [illegible] course are given points, and enough points win them a Certificate of Achievement. Along with written recommendations, these certificates provide a strong basis for favorable parole considera- [illegible] Many former inmates have reported that the certificates also helped them to get jobs.

Now undergoing trial is a "contingency management" plan under [illegible] student contracts at the end of each day's classroom work to [illegible] a certain number of frames the next day. A frame comprises [illegible] question and one answer in a programed instruction course. A contract is an agreement, recorded on a form, between the student and the supervisor. The student is free to specify the number of frames he will do provided this is at least equal to his accomplishment during the baseline period at the beginning of the course. The student also agrees to take the tests assigned by the supervisor at the appropriate points in the course. And student and supervisor agree that upon completion of a certain number of frames or of a test the student will be free to take a 15-minute break. (The amount of work to be completed before a break depends upon the total amount for the day as specified in the contract.) The agreement makes it possible for each student to average one break an hour.

The breaks are taken in a room—the "reinforcing event" area—fitted out with a coffeemaker and supplies, newspapers, books, magazines, letter-writing materials, shoe shining equipment, crossword puzzles, playing cards, checker and chess sets, and a radio.

An experiment that preceded the adoption of this plan involved 16 students. First they worked through a 3-week baseline period having two scheduled breaks per day. Then came 4 weeks managed by the experimenter. During the first two of these weeks he set the performance level at 20 percent higher than the baseline average; during the last 2 weeks, he raised it another 20 percent. Most students achieved these increases.

Then came 2 weeks of self-management, with the students themselves at the end of each day setting the amount of work they would do the following day. In almost every case they agreed to work and did work faster than during the second phase, when the experimenter was calling the pace. Frames completed per hour averaged 61 during the baseline period, 101 during the experimenter-managed period, and 125 during the self-management period.

These increases in work per hour were accompanied by a decrease in the number of hours worked. During the second and third periods, the students were permitted to leave the study area when they had completed the stipulated or agreed-upon number of frames and the appropriate tests. They could go back to the dormitory and rest, work out in the gym, talk to friends, or engage in other free-time activities. Consequently, the number of hours worked per day dropped from slightly more than 5 in the baseline period, to 4.35 in the experimenter-managed period, to 3.4 in the self-management phase. But the total work completed rose from 320 frames in the baseline period, to 405, to 435. The increase in frames completed did not adversely affect test performance.

In sum, the experiment indicates:

1. The knowledge that a reward is waiting spurs students on. This is so whether the work to be done is set by the experimenter or by the student. But when it is set by the student, productivity seems to increase still further.

2. In many cases, permission to leave the experimental area at the completion of the performance contract for the day acted as a more powerful reinforcer than the immediate reward—one or more of the activities available during the 15-minute breaks periods. After students were told, part way through the experiment, that they might continue to study rather than take an earned break, the group as a whole chose continued work as often as it chose immediate relaxation.

In addition to the built-in reinforcement of programed instruction and the extrinsic, tangible rewards offered at Draper, something else

is at work. In the process of learning to be a student, Doctor McKee observes, a man learns to enjoy certain intellectual pursuits. He reads the newspapers, he picks up a book, he listens to the news on TV, he carries on an intellectual conversation—his whole world is changing and opening up. He is going from such reinforcers as a party, free time, and points toward a certificate to find intrinsic rewards in the subject matter itself and in the process of his development. This is theory, but you see it working in the lives of all of us.

The attitude adopted by the staff is also a motivating factor, Doctor McKee believes. "We attempt to be firm but not punitive," he says, "helping but not totally permissive, and flexible but not vacillating. By employing positive rather than negative reinforcement whenever possible, an atmosphere has been created that is much different from the hostile, punitive one expected by most inmates."

As an example, he cites his own behavior when he helps administer a test for a high school equivalency certificate. It's a long test, dragging on for several hours. Since the typical inmate's span of attention is short, and since McKee knows from experience that the inmate may say "The with it" and walk off, the director keeps coming back and showing interest. "How are you doing—any problems?" he'll ask. "I don't tell him any answers," McKee says, "but I get him to say, 'Well, yeah, this part I just took,' or something like that. And I say, 'Well, let me see,' and look at the part and say, 'Yes, you've got some tough questions there. Better go back over what you've been reading and writing to make sure you've got the right answers. I'll be back.'" What I'm trying to do is to maintain alert behavior—keep them sticking with the job and not bugging out.

"That's what they've been doing all their lives—bugging out, escaping. And strangely enough, this escape behavior has been reinforced. Rob a house, forge a check, steal a car—and run away. Girl friend squeezing you in? The job getting you down? Run away.

"Even people in correctional work have been reinforcing such behavior. An inmate will get tired of the work he's been assigned to. Or he'll get tired of the person he's working with. So he starts manipulating a change. He'll tell the classification officer: 'I'm bugging out of this. I need a different job. My supervisor's down on me—I don't know why.' And he'll keep trying and after a while he'll get his change."

From staff interviews with prospective students, McKee suspects that a large proportion of the inmates who volunteered for school were simply running away once again. But he accepted them because in his project there is nowhere to run to, except back to the job they escaped from.

A "Second Language"

Doctor McKee emphasizes that with prisoners—and probably any other population, for that matter - programed instruction has to be supplemented by discussion groups and sometimes by individual counseling or teacher-student conferences. The inescapable inadequacy of many P.I. courses, standing by themselves, was brought home to him one day a few years ago when he congratulated a trainee on having made the extraordinarily high grade of 96 in a high-school-level grammar course. The trainee gave a deprecatory smile in response and said: "This here English, Doc, don't give me no trouble nohow." Like many other students, he had learned the rules but wasn't applying them.

The project then tried the seminar approach—trainees meeting in groups with a teacher and working together at speech modification. This was much more successful. As the trainees listened to one another, they learned to detect errors, which they called to the group's attention.

Now the staff is experimenting with what it calls the "second language" approach; that is, teaching standard English by the oral methods used in teaching a foreign language.

In this approach a man's present speech, no matter how poor by conventional standards, is never criticized. It is the one he has picked up as a child, and it is usually quite effective in meeting his needs to communicate with his usual associates. The trainees are simply told that the school wants to give them the ability to use another kind of speech on appropriate occasions, such as when applying for a job or meeting a girl friend's parents. "We all have different levels of speech," points out Sally Roy, a former public school teacher who is now a research associate with the Draper project. "A child of five will speak to his mother one way, to his friends another, and to his teacher a third. We speak one way to the dog and another to the Mayor. The hope is that the trainees will use this different level we are giving them more and more often and that eventually it will become their usual level."

The project got the idea from St. Mary's Dominican College Business School in New Orleans, a basic education center for the Job Corps. In training Negro, Cajun, and other disadvantaged girls to be secretaries, staff members from Draper found, Dominican College was trying not to correct their language but to give them a new one for use on the job. It called the new language "business speech."

In its second-language experiment, the staff at Draper gives extensive drill work on the most common errors noticed during talks with the trainees—errors exemplified by such sentences as "John and me want to go to town," "He don't know no better," and "They is ready

to fight." The trainees hear over and over again, on tape, the correctly spoken version of these and hundreds of other examples. They also listen to themselves at frequent intervals. And there is group work, including mock job interviews, some of it recorded by a videotape machine.

Has any employer said, "I can't take this man because he doesn't talk well enough?"

"It happened in New Orleans," answers Doctor McKee. "People there said, 'We can't take this girl; she doesn't speak right; she'd give us a bad image.' We don't know whether or not it has happened here. But it seems reasonable to suppose that an employer hires a man on the basis of the total image he casts, including his ability and his self-confidence, and that his speech is part of this image. Even an employer who himself says 'He don't' cannot help being impressed by a man who speaks well. Rehabilitation is a cluster of things, including attitude changes. We think that proper speech is part of the cluster. It is not merely that the man who learns what we are calling a second language has acquired a new skill but that he is enhanced by having done so. People look twice at him and think that he is worth more. He himself has a greater feeling of worth and a sense of belonging."

For the Future

Aided by a new grant from the Department of Labor, Doctor McKee expects to continue the program of education and vocational training and to make more extensive and rigorous followups. He hopes to answer these questions, among others:

- What is the most effective type of training program, as measured by work adjustment and recidivism? Can P.I. simulate real work situations, beyond that of a job interview? Can realistic work-stress conditions be simulated and the means of handling them be transferred to actual job conditions following release?
- What specific barriers, particularly those related to employer attitudes, make it more difficult for the offender to find and hold a job?
- Do released convicts who receive "labor mobility" funds (small grants of Federal money to tide them over until the first paycheck comes in) or Federal bonding assistance, or both, have a better post-release record than those who do not?
- How can an inmate's behavior, not merely during the hours given to the training program but throughout the day, be shaped to conform to desired standards? Involved are (*a*) deciding which kinds of behavior are desirable, because they make for a successful transition from the institution to a job in the community, and which kinds of behavior are undesirable, (*b*) determining the frequency with which each kind

of behavior occurs in the sample of men to be studied, and (*c*) selecting, applying, and measuring the effectiveness of measures—among them, probably, certain changes in the attitudes of the custodial staff—to encourage one kind of behavior and discourage another. This, then, is a major, long-term experiment in behavior modification and one that is dear to Doctor McKee's heart.

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BIOLOGICAL RHYTHMS AND THE PINEAL GLAND

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Studies led by Doctor Axelrod at the National Institute of Mental Health and by Doctor Wurtman now at the Massachusetts Institute of Technology, are beginning to offer clues to the function of the mysterious pineal gland and its possible effect upon the integration of behavior, pigmentation, sexual development, protein metabolism, and the rhythmic adaptation of the individual to an environment that requires constant anticipation. This unique gland may tell us a good deal about the interrelation between energy metabolism, mood, sleep-waking cycles, sexual maturation and development. The pineal seems to be one of the integrative organs that may control hormones, critical enzymes, and active neurochemicals.

History

Until the mid-1950's the pineal gland was considered uninteresting. In ignorance of its function, physiologists assumed that it had no relevant function excepting as an evolutionary remnant. A leading physiology text of the 1930's summarized the view propounded to students:

> The pineal gland has so far not been proved to have any function in metabolism. It is interesting as a vestigial remnant of a primitive dorsal eye. It has been claimed that its removal in young animals, or destructive pineal tumors in young boys, result in obesity, premature sexual development and early maturity. Feeding of tadpoles with pineal substance rapidly produces pallor due to contraction of the melanophors in the skin.

Until very recently, neurophysiologists had a similarly contemptuous view of glial cells, the small brain cells that surround neurons but which do not themselves transmit messages. When it was discovered that glia had a function in the brain, nourishing nerve cells and perhaps also modulating their firing ability, a whole new dimension

of brain research began. A similar change of attitude occurred among physiologists regarding cartilage when it was discovered to have bioelectric properties that are not purely structural. The story of the pineal research follows a similar pattern.

Location

The pineal gland is a small cone of tissue situated very nearly in the middle of the brain, back behind the ears. Its strategic location places it near the spiraling formation of the caudate nucleus, which is a kind of biochemical factory and storehouse of important brain substances. Nearby is the thalamus, a large nucleus—shaped somewhat like a brazil nut—which is critical in relaying messages between body and upper brain. The thalamus may act as a kind of editorial room for brain transmission and seems to play an important role in sleep and many emotional behaviors.

Just beneath and to the side of the pineal lie the double nuclei of the visual system, the lateral geniculate. Adjacent is one of the brain's most complex and important centers for survival: the hypothalamus. It is this complex structure that governs so many controls that maintain life: regulating blood pressure, temperature, pulse, hunger, respiration, hormonal responses to emergencies, and indeed, primitive emotions of rage or of pleasure. Many of the automatic functions that keep us physiologically stable are regulated from the hypothalamus, as are quite a few of the animal reactions that permit us to adapt to quick changes in the world around us. Sexual function and the ability to fight or to flee are among the controls of this important brain region. Until recently these brain regions attracted considerable scientific interest, but their relation to the nearby pineal gland was not considered worth investigating.

Clinical Data

During the mid-1950's, cases of pineal destruction were reviewed in an effort to detect from a literature search how the pineal affected endocrine functions. An underfunctioning pineal gland appeared to advance puberty, while an overactive pineal seemed to delay sexual development. This was not a trivial symptom, as one can easily see in a single case. A boy who showed signs of abnormal pressure within the brain at about age 5 was placed under observation and treated with irradiation at about age 9. By the time he was 14, he showed no abnormal glandular symptoms from any residue of pineal malignancy or from the destruction of the pineal performed by X-ray therapy. However, he showed absolutely no sign of sexual maturation. At 14 a child might

be considered "slow," but at 18 a prepubescent state could be a serious detriment to social development and a cause of lifelong difficulties.

Because of the strange correlations between pineal damage and sexual maturation rate, many researchers conjectured that the pineal influences gonadal activity by means of some intermediate hormone. Perhaps the function of the pineal hormone is inhibitory, acting indirectly as a kind of "stop" signal. The nature of such a hormone and its possible mode of action was first suggested by the work of Doctors Axelrod and Wurtman.

The Discovery of Melatonin

In 1959, Dr. Aaron Lerner and his associates at Yale isolated an unusual substance from pineal tissue, one that has been widely discussed ever since—melatonin. The discovery of melatonin had been strangely motivated.

In 1917, it had been observed that pineal tissue rapidly blanched the skin of a tadpole or frog. Something in pineal tissue exerted a powerful influence upon the pigment granules in skin. Perhaps this was a substance responsible for skin discolorations and blemishes. In 1959, the skin-blanching substance in pineal tissue was isolated and identified. Because of its influence upon melanin, which darkens our pigmentation, the newly discovered compound was called melatonin.

Melatonin is a complex molecule. It is related to a chemical family known as indoles, which have considerable influence upon brain function. A more familiar molecule with indole structure is serotonin. Serotonin is sometimes called a brain hormone and a neurotransmitter. A great deal of the body's serotonin is concentrated in the intestines and blood. Serotonin is presumed to be important in stimulating the action of smooth muscle, making possible the muscular contractions involved in digestion. Drugs that interfere with serotonin can have a profound effect upon sleep and behavior. Quite a few researchers have postulated that interference with serotonin may be a factor in psychosis and in mental retardation.

It was by an unexpected route that Doctor Axelrod and his associates first discovered the connection between serotonin and its cousin, melatonin.

Once the team of scientists at Yale had elucidated the structure of the melatonin, a molecule closely related to serotonin, Doctor Axelrod began wondering what kind of catalyst in the body might produce such a molecule. Biological catalysts—enzymes—are the middlemen of the continuous metabolism we call life. Throughout the body, at all times of day and night, enzymes in great variety are busily breaking down one chemical molecule and transforming it into another. Food, thus, becomes tissue, and tissue performs its functions. Enzymes, the

incessant drones, are abundant, but each one is also limited in what it can do. Doctor Axelrod happened to be interested in a particular kind of enzymatic activity. He was interested in the way these enzymes would work in transferring a group of atoms, called the methyl group, to an oxygen atom. Starting from this limited interest, he began a decade of pineal research, for it was the methyl group of melatonin that attracted his attention. What Doctor Axelrod was about to find was the manner in which a relatively inconspicuous brain chemical is manufactured by a relatively ubiquitous neurochemical.

New Molecules from Old: Melatonin from Serotonin

Dr. Axelrod and his associates began their pineal adventure with a search for an O-methylating enzyme. This is the enzyme that would hinge a methyl group to an oxygen atom on a molecule. Since melatonin existed in pineal tissue, this was the only reasonable tissue to search for a melatonin-building enzyme. Accordingly, Doctor Axelrod and his associate Doctor Weissbach took some pineal gland from a cow and incubated it with a form of serotonin (N-Acetylserotonin) and a radioactive substance that contained a methyl group. Soon the radioactive substance had relinquished its methyl group to the N-Acetylserotonin, thereby making the serotonin radioactive and highly identifiable. However, the new compound containing the added methyl group on its oxygen atom was no longer serotonin. As paper chromotography soon divulged, the new substance was melatonin. It was produced by a methylating action on N-Acetylserotonin. This meant that there had to be an enzyme in the cow pineal that could transform serotonin into melatonin.

By a series of experiments, Doctor Axelrod and his associates set out to find this enzyme. Their discovery was an important one. They called the newly detected enzyme hydroxyindole-O-methyl transferase (HIOMT), which described its chemical structure and function. They inevitably wondered whether the enzyme existed throughout the brain and nervous system. After a thoroughgoing assay of body and brain tissues, the answer was startling. This enzyme was found to be *only* in the pineal gland of mammals. (In lower forms of life such as fish and amphibians this enzyme is also present in the eye and the brain.)

The reseachers now wondered whether melatonin production had some function that might be found by comparing the animal species in which it was found. They examined pineal tissues from hens and other birds, from monkeys, rats, and other mammals, and saw that the activity of the melatonin-producing enzyme differed remarkably from species to species. However, in each species the enzyme was exclusively located in the pineal.

At the time this research was in progress at the National Institutes of Health, scientists (the late Dr. Nicholas Giarman and Dr. Wilbur Day) were discovering that the pineal is a great repository of serotonin and other brain amines. Thus the pineal contained the essential ingredients for producing melatonin and perhaps other constituents of endocrine and brain activity.

In 1960 pineal biochemistry and physiology hovered on a threshold. The subject was beginning to attract the interest of biochemists. Here was a gland that secreted a strange substance capable of blanching skin and perhaps influencing sex hormones. This peculiar chemical was the product of an exclusively pineal enzyme which acted upon the important brain hormone, serotonin. Despite some biochemical interest, the curious pineal was a neglected organ, virtually unrecognized by brain researchers and endocrinologists. Indeed, it was a mystery the shape of a small cone, the size of a fingertip, in the middle of the brain. Nobody had any inkling what function it might perform.

At this point, circumstance brought about a fortunate scientific collaboration. Axelrod, with his specific interest in the melatonin-producing enzyme, was joined by a young clinician and endocrinologist, Richard Wurtman.

Wurtman was driven by a different interest. In 1960 he had been studying another important family of brain chemicals, the catecholamines. These include adrenaline and noradrenaline, which are major substances in neural transmission, in the regulations of moods, and presumably of some importance in governing the way in which the nervous system controls the output and use of hormones. Less than a decade ago, as pineal biochemistry began, the organ itself was considered vestigial and was underrated even by those who were about to discover its importance.

"When I went to work with Axelrod," Wurtman recalled, "I thought it would be worthwhile to find out what it was in pineal extract that retards ovarian maturation. When pineal extracts were injected into rats, it was found that the animals experienced a delay in ovarian development."

At about this time Dr. Virginia Fiske, a Wellesley College teacher, observed that animals kept in light had smaller pineal glands than those animals exposed to darkness. A number of biologists had obtained evidence that light stimulated the development of the gonads. Was there a relation between pineal function and gonadal development? Was the pineal response perhaps a necessary intermediary in the effects of light on the gonads? While still a medical student at Harvard, Wurtman had done some experiments suggesting that the pineal was a necessary intermediary. In studying this relationship, he and Axelrod were to uncover an important property of the pineal gland, one that had been a stumbling block in prior attempts to deduce

its function from case histories of patients. This was the fact that melatonin and serotonin are not at constant levels in the gland, but fluctuating.

Light and Darkness: Pineal Size and Melatonin Production

What biochemical activity in the pineal gland might respond to light? A simple study was designed to answer that question. A group of rats was kept in darkness for 6 days, while another identical group was kept in constant light. Pineals taken from both groups were weighed and assayed for HIOMT activity. The animals kept in light had small pineals and the melatonin-forming enzyme was not very active. However, the rats left in darkness had larger pineals. Darkness also markedly stimulated the enzyme that produced melatonin.

Other enzymes were also found in pineal tissue. One was monoamine oxidase, which destroys noradrenaline and other catecholamines. Researchers concerned with depression have long thought that the activity of this enzyme could be harnessed to influence moods. Agents that block its action (MAO inhibitors) have become part of the drug therapy used to improve the moods of depressed people. Despite the influence of light and dark on HIOMT, the melatonin-producing enzyme, monoamine oxidase, was no different in the pineal tissue of light-exposed rats than in the pineals of dark-exposed rats. Light and darkness seemed to exert their effects specifically upon the melatonin system.

Light, Dark, and Melatonin Production in Diurnal Animals

The rat is a nocturnal animal, one who generally rests when it is light, and scavenges for food during the hours of darkness. The rats kept in darkness had unusually large pineals. The activity of the melatonin-forming enzyme was doubled when the animal stayed in constant darkness. This enzyme, to be known by its abbreviation HIOMT, converted serotonin into melatonin. The studies of rats had certainly suggested that HIOMT was somehow inhibited by light.

If the pineal were a kind of time-keeping mechanism, one would expect it to show a comparable change in diurnal animals. Would these creatures who act primarily in daylight show the same enzyme phenomenon as the rats? Hens are diurnal, resting in darkness, active by day. In the next study, a group of hens was kept in constant light, while a comparable group lived in constant darkness. The hens who lived in constant light had heavier pineal glands. This suggested that light acted upon the pineal of the diurnal hen the way darkness acted upon the pineal of the nocturnal rat. Indeed, it was the group of hens

kept in darkness that showed a decrease in the activity of HIOMT, the melatonin-producing enzyme. In other words, light seemed to act upon HIOMT to increase its activity in diurnal animals, while darkness increased the activity of the enzyme in nocturnal animals.

Since the pineal gland lies buried deep within the brain, one might wonder how light and darkness would impinge upon the gland. Surely, if the pineal were a kind of biological synchronizer that keeps an animal in tune with his environment by altering brain chemistry according to day and night, there had to be some way by which light could influence the pineal.

How Light May Influence the Pineal Gland

At first it seemed that light might enter directly through the skull. There is some evidence that light penetrates the skulls of birds and other animals. An implanted photoelectric cell within the brain of a blinded creature, for example, has shown the impact of light; thus the pineal might be directly affected by environmental light.

Another alternative was the possibility that light influences pituitary hormones which, in turn, influence the biochemistry of the pineal. On the other hand, light might come indirectly to the pineal through neural messages.

Doctors Wurtman and Axlerod began a process of elimination. They used groups of animals from whom the ovaries had been removed. This eliminated the possibility that pineal activity was light-mediated through some influence upon sex hormones or reproductive glands. These ovariectomized animals continued to show more HIOMT activity when kept in darkness than when kept in light.

The next stage of elimination was the removal of the pituitary. Then, the pineals were taken from animals kept in darkness and from animals kept in light. Again the melatonin-producing enzyme (HIOMT) showed its greatest activity in the pineals of animals kept in darkness. The pituitary was not the source of information about light and darkness, nor were the gonads.

Next, blinded rats were used. The laboratory schedule exposed the sightless animals to continuous illumination or continuous darkness. Melatonin synthesis in pineals taken from blinded rats no longer showed a biochemical response to environmental light or darkness. HIOMT activity was no different among rats kept in light than among rats kept in darkness. Evidently the light that influenced the pineal must have come through the retina, through the eyes. In what possible way would the deeply buried pineal gland be connected to light-bearing nerves of the visual system?

The optical tract resembles a cable system from the eyes to the back of the head. This major bundle of nerve fibers bears light messages

back into the visual portions of the brain. In addition, however, a small bundle of fibers leads from the eyes to another portion of the brain. This latter fiber bundle ends in the lateral hypothalamus; at this point it transmits signals which travel to cell clusters, ganglia, at the upper reaches of the neck in the superior cervical ganglia. This second optic fiber system, whose light messages seem not to be relevant to vision, is known as the inferior accessory optic tract.

If this were the conduit whereby light and dark influenced the pineal, then interruption of the inferior accessory optic tract or the removal of its end points, the superior cervical ganglia, should obliterate the effects of light and dark upon pineal biochemistry. Since the rate of HIOMT activity provided a fine gauge of pineal response to light and dark, this criterion was again used by Doctors Wurtman and Josef Fischer in searching for the pineal's source of light information. Doctor Fischer removed the superior cervical ganglia from rats who were then placed under continuous light or darkness. Pineal tissue showed the same HIOMT activity whether taken from rats in dark or in light. The cervical ganglia had, indeed, been a crucial link in the route of light messages to the pineal.

Evidently light entering through the eyes follows its circuitous route through the inferior accessory optic tract, transmitting impulses to the cervical ganglia in the neck and then somehow to the pineal.

Some 300 years ago the philosopher Descartes proposed that the pineal had a special function in some ways remarkably close to current findings. He imagined that images from the eyes were carried by "strings" to the pineal with its "animal humors." The light stimulus supposedly caused the gland to tilt so that it poured its "humors" down through the hollow centers of "tubes" that nerve fibers were then thought to be. Humors going down the tubelike nerve fibers influenced the muscles, which accordingly contracted or expanded. The notion of the pineal gland as a kind of third eye, or a gland dependent upon the eyes, is an ancient hypothesis. However, the gland does not function the same way in all species.

Birds are quite different from mammals, and pineal function underscores this difference. In recent experiments, Doctor Axelrod collaborated with Dr. Jean K. Lauber and James E. Boyd of the University of Alberta. They performed a systematic study of the effects of light upon melatonin production in chicks. The chicks were reared on a 14-hour day with 10 hours of darkness each night. Some of the chicks were operated upon just 4 days after they hatched. The cervical ganglia were severed from the inferior optic tract. Some of the chicks received a comparably traumatic but sham operation. In this way, the experimenters could be assured that the results were not merely caused by the trauma of surgery. In the sham operations the ganglia were exposed but not removed. Some of the chicks had both eyes removed.

[illegible] inmates have developed courses in personal [illegible] speech, improving the memory, orienta[illegible] subjects. One man who was studying [illegible] for a half year course in welding just [illegible] theory of it. The course in technical [illegible] a few years because employers [illegible] but the welding lessons, like [illegible] by inmates, have become part of [illegible]

[illegible] production of P.I. materials has boomed [illegible] courses are available. The problem [illegible] courses but to select from the [illegible] One new program, though, is definitely [illegible] the aid of offenders—in particular, [illegible] parolees—and it will teach *how to succeed*

Reinforcement

[illegible] instruction has its own built-in reinforce[illegible] gets from finding that an answer is correct (or, if it [illegible] from learning what was wrong and from being encour[illegible] the staff at Draper found that the typical inmate [illegible] after a few weeks. So it has employed a number of tangible [illegible] motivating environment. For instance, students who [illegible] course are given points, and enough points win them a Certificate of Achievement. Along with written recommendations, these certificates provide a strong basis for favorable parole considera[illegible] Many former inmates have reported that the certificates also helped them to get jobs.

Now undergoing trial is a "contingency management" plan under [illegible] student contracts at the end of each day's classroom work to [illegible] a certain number of frames the next day. A frame comprises [illegible] question and one answer in a programed instruction course. A contract is an agreement, recorded on a form, between the student and the supervisor. The student is free to specify the number of frames he will do provided this is at least equal to his accomplishment during the baseline period at the beginning of the course. The student also agrees to take the tests assigned by the supervisor at the appropriate points in the course. And student and supervisor agree that upon completion of a certain number of frames or of a test the student will be free to take a 15-minute break. (The amount of work to be completed before a break depends upon the total amount for the day as specified in the contract.) The agreement makes it possible for each student to average one break an hour.

The breaks are taken in a room—the "reinforcing event" area—fitted out with a coffeemaker and supplies, newspapers, books, magazines, letter-writing materials, shoe shining equipment, crossword puzzles, playing cards, checker and chess sets, and a radio.

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In sum, the experiment indicates:

1. The knowledge that a reward is waiting spurs students on. This is so whether the work to be done is set by the experimenter or by the student. But when it is set by the student, productivity seems to increase still further.

2. In many cases, permission to leave the experimental area at the completion of the performance contract for the day acted as a more powerful reinforcer than the immediate reward—one or more of the activities available during the 15-minute break periods. After students were told, part way through the experiment, that they might continue to study rather than take an earned break, the group as a whole chose continued work as often as it chose immediate relaxation.

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is at work. In the process of learning to be a student, Doctor McKee observes, a man learns to enjoy certain intellectual pursuits. He reads the newspapers, he picks up a book, he listens to the news on TV, he carries on an intellectual conversation—his whole world is changing and opening up. He is going from such reinforcers as a party, free time, and points toward a certificate to find intrinsic rewards in the subject matter itself and in the process of his development. This is theory, but you see it working in the lives of all of us.

The attitude adopted by the staff is also a motivating factor, Doctor McKee believes. "We attempt to be firm but not punitive," he says, "helping but not totally permissive, and flexible but not vacillating. By employing positive rather than negative reinforcement whenever possible, an atmosphere has been created that is much different from the hostile, punitive one expected by most inmates."

As an example, he cites his own behavior when he helps administer a test for a high school equivalency certificate. It's a long test, dragging on for several hours. Since the typical inmate's span of attention is short, and since McKee knows from experience that the inmate may say "The with it" and walk off, the director keeps coming back and showing interest. "How are you doing—any problems?" he'll ask. "I don't tell him any answers," McKee says, "but I get him to say, 'Well, yeah, this part I just took,' or something like that. And I say, 'Well, let me see,' and look at the part and say, 'Yes, you've got some tough questions there. Better go back over what you've been reading and writing to make sure you've got the right answers. I'll be back.'" What I'm trying to do is to maintain alert behavior—keep them sticking with the job and not bugging out.

"That's what they've been doing all their lives—bugging out, escaping. And strangely enough, this escape behavior has been reinforced. Rob a house, forge a check, steal a car—and run away. Girl friend squeezing you in? The job getting you down? Run away.

"Even people in correctional work have been reinforcing such behavior. An inmate will get tired of the work he's been assigned to. Or he'll get tired of the person he's working with. So he starts manipulating a change. He'll tell the classification officer: 'I'm bugging out of this. I need a different job. My supervisor's down on me—I don't know why.' And he'll keep trying and after a while he'll get his change."

From staff interviews with prospective students, McKee suspects that a large proportion of the inmates who volunteered for school were simply running away once again. But he accepted them because in his project there is nowhere to run to, except back to the job they escaped from.

A "Second Language"

Doctor McKee emphasizes that with prisoners—and probably any other population, for that matter—programed instruction has to be supplemented by discussion groups and sometimes by individual counseling or teacher-student conferences. The inescapable inadequacy of many P.I. courses, standing by themselves, was brought home to him one day a few years ago when he congratulated a trainee on having made the extraordinarily high grade of 96 in a high-school-level grammar course. The trainee gave a deprecatory smile in response and said: "This here English, Doc, don't give me no trouble nohow." Like many other students, he had learned the rules but wasn't applying them.

The project then tried the seminar approach—trainees meeting in groups with a teacher and working together at speech modification. This was much more successful. As the trainees listened to one another, they learned to detect errors, which they called to the group's attention.

Now the staff is experimenting with what it calls the "second language" approach; that is, teaching standard English by the oral methods used in teaching a foreign language.

In this approach a man's present speech, no matter how poor by conventional standards, is never criticized. It is the one he has picked up as a child, and it is usually quite effective in meeting his needs to communicate with his usual associates. The trainees are simply told that the school wants to give them the ability to use another kind of speech on appropriate occasions, such as when applying for a job or meeting a girl friend's parents. "We all have different levels of speech," points out Sally Roy, a former public school teacher who is now a research associate with the Draper project. "A child of five will speak to his mother one way, to his friends another, and to his teacher a third. We speak one way to the dog and another to the Mayor. The hope is that the trainees will use this different level we are giving them more and more often and that eventually it will become their usual level."

The project got the idea from St. Mary's Dominican College Business School in New Orleans, a basic education center for the Job Corps. In training Negro, Cajun, and other disadvantaged girls to be secretaries, staff members from Draper found, Dominican College was trying not to correct their language but to give them a new one for use on the job. It called the new language "business speech."

In its second-language experiment, the staff at Draper gives extensive drill work on the most common errors noticed during talks with the trainees—errors exemplified by such sentences as "John and me want to go to town," "He don't know no better," and "They is ready

to fight." The trainees hear over and over again, on tape, the correctly spoken version of these and hundreds of other examples. They also listen to themselves at frequent intervals. And there is group work, including mock job interviews, some of it recorded by a videotape machine.

Has any employer said, "I can't take this man because he doesn't talk well enough?"

"It happened in New Orleans," answers Doctor McKee. "People there said, 'We can't take this girl; she doesn't speak right; she'd give us a bad image.' We don't know whether or not it has happened here. But it seems reasonable to suppose that an employer hires a man on the basis of the total image he casts, including his ability and his self-confidence, and that his speech is part of this image. Even an employer who himself says 'He don't' cannot help being impressed by a man who speaks well. Rehabilitation is a cluster of things, including attitude changes. We think that proper speech is part of the cluster. It is not merely that the man who learns what we are calling a second language has acquired a new skill but that he is enhanced by having done so. People look twice at him and think that he is worth more. He himself has a greater feeling of worth and a sense of belonging."

For the Future

Aided by a new grant from the Department of Labor, Doctor McKee expects to continue the program of education and vocational training and to make more extensive and rigorous followups. He hopes to answer these questions, among others:

- What is the most effective type of training program, as measured by work adjustment and recidivism? Can P.I. simulate real work situations, beyond that of a job interview? Can realistic work-stress conditions be simulated and the means of handling them be transferred to actual job conditions following release?
- What specific barriers, particularly those related to employer attitudes, make it more difficult for the offender to find and hold a job?
- Do released convicts who receive "labor mobility" funds (small grants of Federal money to tide them over until the first paycheck comes in) or Federal bonding assistance, or both, have a better post-release record than those who do not?
- How can an inmate's behavior, not merely during the hours given to the training program but throughout the day, be shaped to conform to desired standards? Involved are (*a*) deciding which kinds of behavior are desirable, because they make for a successful transition from the institution to a job in the community, and which kinds of behavior are undesirable, (*b*) determining the frequency with which each kind

of behavior occurs in the sample of men to be studied, and (c) selecting, applying, and measuring the effectiveness of measures—among them, probably, certain changes in the attitudes of the custodial staff—to encourage one kind of behavior and discourage another. This, then, is a major, long-term experiment in behavior modification and one that is dear to Doctor McKee's heart.

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BIOLOGICAL RHYTHMS AND THE PINEAL GLAND

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Studies led by Doctor Axelrod at the National Institute of Mental Health and by Doctor Wurtman now at the Massachusetts Institute of Technology, are beginning to offer clues to the function of the mysterious pineal gland and its possible effect upon the integration of behavior, pigmentation, sexual development, protein metabolism, and the rhythmic adaptation of the individual to an environment that requires constant anticipation. This unique gland may tell us a good deal about the interrelation between energy metabolism, mood, sleep-waking cycles, sexual maturation and development. The pineal seems to be one of the integrative organs that may control hormones, critical enzymes, and active neurochemicals.

History

Until the mid-1950's the pineal gland was considered uninteresting. In ignorance of its function, physiologists assumed that it had no relevant function excepting as an evolutionary remnant. A leading physiology text of the 1930's summarized the view propounded to students:

> The pineal gland has so far not been proved to have any function in metabolism. It is interesting as a vestigial remnant of a primitive dorsal eye. It has been claimed that its removal in young animals, or destructive pineal tumors in young boys, result in obesity, premature sexual development and early maturity. Feeding of tadpoles with pineal substance rapidly produces pallor due to contraction of the melanophors in the skin.

Until very recently, neurophysiologists had a similarly contemptuous view of glial cells, the small brain cells that surround neurons but which do not themselves transmit messages. When it was discovered that glia had a function in the brain, nourishing nerve cells and perhaps also modulating their firing ability, a whole new dimension

of brain research began. A similar change of attitude occurred among physiologists regarding cartilage when it was discovered to have bioelectric properties that are not purely structural. The story of the pineal research follows a similar pattern.

Location

The pineal gland is a small cone of tissue situated very nearly in the middle of the brain, back behind the ears. Its strategic location places it near the spiraling formation of the caudate nucleus, which is a kind of biochemical factory and storehouse of important brain substances. Nearby is the thalamus, a large nucleus—shaped somewhat like a brazil nut—which is critical in relaying messages between body and upper brain. The thalamus may act as a kind of editorial room for brain transmission and seems to play an important role in sleep and many emotional behaviors.

Just beneath and to the side of the pineal lie the double nuclei of the visual system, the lateral geniculate. Adjacent is one of the brain's most complex and important centers for survival: the hypothalamus. It is this complex structure that governs so many controls that maintain life: regulating blood pressure, temperature, pulse, hunger, respiration, hormonal responses to emergencies, and indeed, primitive emotions of rage or of pleasure. Many of the automatic functions that keep us physiologically stable are regulated from the hypothalamus, as are quite a few of the animal reactions that permit us to adapt to quick changes in the world around us. Sexual function and the ability to fight or to flee are among the controls of this important brain region. Until recently these brain regions attracted considerable scientific interest, but their relation to the nearby pineal gland was not considered worth investigating.

Clinical Data

During the mid-1950's, cases of pineal destruction were reviewed in an effort to detect from a literature search how the pineal affected endocrine functions. An underfunctioning pineal gland appeared to advance puberty, while an overactive pineal seemed to delay sexual development. This was not a trivial symptom, as one can easily see in a single case. A boy who showed signs of abnormal pressure within the brain at about age 5 was placed under observation and treated with irradiation at about age 9. By the time he was 14, he showed no abnormal glandular symptoms from any residue of pineal malignancy or from the destruction of the pineal performed by X-ray therapy. However, he showed absolutely no sign of sexual maturation. At 14 a child might

be considered "slow," but at 18 a prepubescent state could be a serious detriment to social development and a cause of lifelong difficulties.

Because of the strange correlations between pineal damage and sexual maturation rate, many researchers conjectured that the pineal influences gonadal activity by means of some intermediate hormone. Perhaps the function of the pineal hormone is inhibitory, acting indirectly as a kind of "stop" signal. The nature of such a hormone and its possible mode of action was first suggested by the work of Doctors Axelrod and Wurtman.

The Discovery of Melatonin

In 1959, Dr. Aaron Lerner and his associates at Yale isolated an unusual substance from pineal tissue, one that has been widely discussed ever since—melatonin. The discovery of melatonin had been strangely motivated.

In 1917, it had been observed that pineal tissue rapidly blanched the skin of a tadpole or frog. Something in pineal tissue exerted a powerful influence upon the pigment granules in skin. Perhaps this was a substance responsible for skin discolorations and blemishes. In 1959, the skin-blanching substance in pineal tissue was isolated and identified. Because of its influence upon melanin, which darkens our pigmentation, the newly discovered compound was called melatonin.

Melatonin is a complex molecule. It is related to a chemical family known as indoles, which have considerable influence upon brain function. A more familiar molecule with indole structure is serotonin. Serotonin is sometimes called a brain hormone and a neurotransmitter. A great deal of the body's serotonin is concentrated in the intestines and blood. Serotonin is presumed to be important in stimulating the action of smooth muscle, making possible the muscular contractions involved in digestion. Drugs that interfere with serotonin can have a profound effect upon sleep and behavior. Quite a few researchers have postulated that interference with serotonin may be a factor in psychosis and in mental retardation.

It was by an unexpected route that Doctor Axelrod and his associates first discovered the connection between serotonin and its cousin, melatonin.

Once the team of scientists at Yale had elucidated the structure of the melatonin, a molecule closely related to serotonin, Doctor Axelrod began wondering what kind of catalyst in the body might produce such a molecule. Biological catalysts—enzymes—are the middlemen of the continuous metabolism we call life. Throughout the body, at all times of day and night, enzymes in great variety are busily breaking down one chemical molecule and transforming it into another. Food, thus, becomes tissue, and tissue performs its functions. Enzymes, the

incessant drones, are abundant, but each one is also limited in what it can do. Doctor Axelrod happened to be interested in a particular kind of enzymatic activity. He was interested in the way these enzymes would work in transferring a group of atoms, called the methyl group, to an oxygen atom. Starting from this limited interest, he began a decade of pineal research, for it was the methyl group of melatonin that attracted his attention. What Doctor Axelrod was about to find was the manner in which a relatively inconspicuous brain chemical is manufactured by a relatively ubiquitous neurochemical.

New Molecules from Old: Melatonin from Serotonin

Dr. Axelrod and his associates began their pineal adventure with a search for an O-methylating enzyme. This is the enzyme that would hinge a methyl group to an oxygen atom on a molecule. Since melatonin existed in pineal tissue, this was the only reasonable tissue to search for a melatonin-building enzyme. Accordingly, Doctor Axelrod and his associate Doctor Weissbach took some pineal gland from a cow and incubated it with a form of serotonin (N-Acetylserotonin) and a radioactive substance that contained a methyl group. Soon the radioactive substance had relinquished its methyl group to the N-Acetylserotonin, thereby making the serotonin radioactive and highly identifiable. However, the new compound containing the added methyl group on its oxygen atom was no longer serotonin. As paper chromotography soon divulged, the new substance was melatonin. It was produced by a methylating action on N-Acetylserotonin. This meant that there had to be an enzyme in the cow pineal that could transform serotonin into melatonin.

By a series of experiments, Doctor Axelrod and his associates set out to find this enzyme. Their discovery was an important one. They called the newly detected enzyme hydroxyindole-O-methyl transferase (HIOMT), which described its chemical structure and function. They inevitably wondered whether the enzyme existed throughout the brain and nervous system. After a thoroughgoing assay of body and brain tissues, the answer was startling. This enzyme was found to be *only* in the pineal gland of mammals. (In lower forms of life such as fish and amphibians this enzyme is also present in the eye and the brain.)

The reseachers now wondered whether melatonin production had some function that might be found by comparing the animal species in which it was found. They examined pineal tissues from hens and other birds, from monkeys, rats, and other mammals, and saw that the activity of the melatonin-producing enzyme differed remarkably from species to species. However, in each species the enzyme was exclusively located in the pineal.

At the time this research was in progress at the National Institutes of Health, scientists (the late Dr. Nicholas Giarman and Dr. Wilbur Day) were discovering that the pineal is a great repository of serotonin and other brain amines. Thus the pineal contained the essential ingredients for producing melatonin and perhaps other constituents of endocrine and brain activity.

In 1960 pineal biochemistry and physiology hovered on a threshold. The subject was beginning to attract the interest of biochemists. Here was a gland that secreted a strange substance capable of blanching skin and perhaps influencing sex hormones. This peculiar chemical was the product of an exclusively pineal enzyme which acted upon the important brain hormone, serotonin. Despite some biochemical interest, the curious pineal was a neglected organ, virtually unrecognized by brain researchers and endocrinologists. Indeed, it was a mystery the shape of a small cone, the size of a fingertip, in the middle of the brain. Nobody had any inkling what function it might perform.

At this point, circumstance brought about a fortunate scientific collaboration. Axelrod, with his specific interest in the melatonin-producing enzyme, was joined by a young clinician and endocrinologist, Richard Wurtman.

Wurtman was driven by a different interest. In 1960 he had been studying another important family of brain chemicals, the catecholamines. These include adrenaline and noradrenaline, which are major substances in neural transmission, in the regulations of moods, and presumably of some importance in governing the way in which the nervous system controls the output and use of hormones. Less than a decade ago, as pineal biochemistry began, the organ itself was considered vestigial and was underrated even by those who were about to discover its importance.

"When I went to work with Axelrod," Wurtman recalled, "I thought it would be worthwhile to find out what it was in pineal extract that retards ovarian maturation. When pineal extracts were injected into rats, it was found that the animals experienced a delay in ovarian development."

At about this time Dr. Virginia Fiske, a Wellesley College teacher, observed that animals kept in light had smaller pineal glands than those animals exposed to darkness. A number of biologists had obtained evidence that light stimulated the development of the gonads. Was there a relation between pineal function and gonadal development? Was the pineal response perhaps a necessary intermediary in the effects of light on the gonads? While still a medical student at Harvard, Wurtman had done some experiments suggesting that the pineal was a necessary intermediary. In studying this relationship, he and Axelrod were to uncover an important property of the pineal gland, one that had been a stumbling block in prior attempts to deduce

its function from case histories of patients. This was the fact that melatonin and serotonin are not at constant levels in the gland, but fluctuating.

Light and Darkness: Pineal Size and Melatonin Production

What biochemical activity in the pineal gland might respond to light? A simple study was designed to answer that question. A group of rats was kept in darkness for 6 days, while another identical group was kept in constant light. Pineals taken from both groups were weighed and assayed for HIOMT activity. The animals kept in light had small pineals and the melatonin-forming enzyme was not very active. However, the rats left in darkness had larger pineals. Darkness also markedly stimulated the enzyme that produced melatonin.

Other enzymes were also found in pineal tissue. One was monoamine oxidase, which destroys noradrenaline and other catecholamines. Researchers concerned with depression have long thought that the activity of this enzyme could be harnessed to influence moods. Agents that block its action (MAO inhibitors) have become part of the drug therapy used to improve the moods of depressed people. Despite the influence of light and dark on HIOMT, the melatonin-producing enzyme, monoamine oxidase, was no different in the pineal tissue of light-exposed rats than in the pineals of dark-exposed rats. Light and darkness seemed to exert their effects specifically upon the melatonin system.

Light, Dark, and Melatonin Production in Diurnal Animals

The rat is a nocturnal animal, one who generally rests when it is light, and scavenges for food during the hours of darkness. The rats kept in darkness had unusually large pineals. The activity of the melatonin-forming enzyme was doubled when the animal stayed in constant darkness. This enzyme, to be known by its abbreviation HIOMT, converted serotonin into melatonin. The studies of rats had certainly suggested that HIOMT was somehow inhibited by light.

If the pineal were a kind of time-keeping mechanism, one would expect it to show a comparable change in diurnal animals. Would these creatures who act primarily in daylight show the same enzyme phenomenon as the rats? Hens are diurnal, resting in darkness, active by day. In the next study, a group of hens was kept in constant light, while a comparable group lived in constant darkness. The hens who lived in constant light had heavier pineal glands. This suggested that light acted upon the pineal of the diurnal hen the way darkness acted upon the pineal of the nocturnal rat. Indeed, it was the group of hens

kept in darkness that showed a decrease in the activity of HIOMT, the melatonin-producing enzyme. In other words, light seemed to act upon HIOMT to increase its activity in diurnal animals, while darkness increased the activity of the enzyme in nocturnal animals.

Since the pineal gland lies buried deep within the brain, one might wonder how light and darkness would impinge upon the gland. Surely, if the pineal were a kind of biological synchronizer that keeps an animal in tune with his environment by altering brain chemistry according to day and night, there had to be some way by which light could influence the pineal.

How Light May Influence the Pineal Gland

At first it seemed that light might enter directly through the skull. There is some evidence that light penetrates the skulls of birds and other animals. An implanted photoelectric cell within the brain of a blinded creature, for example, has shown the impact of light; thus the pineal might be directly affected by environmental light.

Another alternative was the possibility that light influences pituitary hormones which, in turn, influence the biochemistry of the pineal. On the other hand, light might come indirectly to the pineal through neural messages.

Doctors Wurtman and Axlerod began a process of elimination. They used groups of animals from whom the ovaries had been removed. This eliminated the possibility that pineal activity was light-mediated through some influence upon sex hormones or reproductive glands. These ovariectomized animals continued to show more HIOMT activity when kept in darkness than when kept in light.

The next stage of elimination was the removal of the pituitary. Then, the pineals were taken from animals kept in darkness and from animals kept in light. Again the melatonin-producing enzyme (HIOMT) showed its greatest activity in the pineals of animals kept in darkness. The pituitary was not the source of information about light and darkness, nor were the gonads.

Next, blinded rats were used. The laboratory schedule exposed the sightless animals to continuous illumination or continuous darkness. Melatonin synthesis in pineals taken from blinded rats no longer showed a biochemical response to environmental light or darkness. HIOMT activity was no different among rats kept in light than among rats kept in darkness. Evidently the light that influenced the pineal must have come through the retina, through the eyes. In what possible way would the deeply buried pineal gland be connected to light-bearing nerves of the visual system?

The optical tract resembles a cable system from the eyes to the back of the head. This major bundle of nerve fibers bears light messages

back into the visual portions of the brain. In addition, however, a small bundle of fibers leads from the eyes to another portion of the brain. This latter fiber bundle ends in the lateral hypothalamus; at this point it transmits signals which travel to cell clusters, ganglia, at the upper reaches of the neck in the superior cervical ganglia. This second optic fiber system, whose light messages seem not to be relevant to vision, is known as the inferior accessory optic tract.

If this were the conduit whereby light and dark influenced the pineal, then interruption of the inferior accessory optic tract or the removal of its end points, the superior cervical ganglia, should obliterate the effects of light and dark upon pineal biochemistry. Since the rate of HIOMT activity provided a fine gauge of pineal response to light and dark, this criterion was again used by Doctors Wurtman and Josef Fischer in searching for the pineal's source of light information. Doctor Fischer removed the superior cervical ganglia from rats who were then placed under continuous light or darkness. Pineal tissue showed the same HIOMT activity whether taken from rats in dark or in light. The cervical ganglia had, indeed, been a crucial link in the route of light messages to the pineal.

Evidently light entering through the eyes follows its circuitous route through the inferior accessory optic tract, transmitting impulses to the cervical ganglia in the neck and then somehow to the pineal.

Some 300 years ago the philosopher Descartes proposed that the pineal had a special function in some ways remarkably close to current findings. He imagined that images from the eyes were carried by "strings" to the pineal with its "animal humors." The light stimulus supposedly caused the gland to tilt so that it poured its "humors" down through the hollow centers of "tubes" that nerve fibers were then thought to be. Humors going down the tubelike nerve fibers influenced the muscles, which accordingly contracted or expanded. The notion of the pineal gland as a kind of third eye, or a gland dependent upon the eyes, is an ancient hypothesis. However, the gland does not function the same way in all species.

Birds are quite different from mammals, and pineal function underscores this difference. In recent experiments, Doctor Axelrod collaborated with Dr. Jean K. Lauber and James E. Boyd of the University of Alberta. They performed a systematic study of the effects of light upon melatonin production in chicks. The chicks were reared on a 14-hour day with 10 hours of darkness each night. Some of the chicks were operated upon just 4 days after they hatched. The cervical ganglia were severed from the inferior optic tract. Some of the chicks received a comparably traumatic but sham operation. In this way, the experimenters could be assured that the results were not merely caused by the trauma of surgery. In the sham operations the ganglia were exposed but not removed. Some of the chicks had both eyes removed.

W[illegible] understanding of the pineal gland help to explain why some [illegible] the nervous system show severe symptoms during certain [illegible] instance, is there a reason why people in temperate cli[illegible] more from ulcers in spring and fall?

[illegible] between pineal secretion and sex hormones may help to [illegible] oddities in medicine, such as of periodic hypertension [illegible] whose abnormal increases in blood pressure occurred like [illegible] 27 days.

If the secretion of the pineal gland indirectly play a "clocking" [illegible] may in animals, we may begin to ask ourselves [illegible] manipulation of light and dark, whether our schedules of [illegible] waking, and the illumination used during our working [illegible] pervasive if elusive influence upon our moods and [illegible] Could the manipulation of light become an important [illegible] preventive and therapeutic medicine? Dr. Edmund Dewan [illegible] suggested that it is possible to entrain ovulation-time in [illegible] the bedroom on certain nights. This implies that [illegible] an impact resembling that of drugs and that it may be [illegible] reckoned with.

[illegible] the last two centuries, people in the United States have lived [illegible] proportion of their lives in electric light which is "non-[illegible]" as Doctor Wurtman says. It does not include all the [illegible] of natural light. Electric light may be deficient, a form [illegible] as far as the brain is concerned.

Many problems still remain to be investigated in biological rhythms. [illegible] of the brain do these rhythms originate? What is the [illegible] mechanism that makes many biological phenomena fluctuate [illegible] course? When these questions are answered, important ad[illegible] medical research will be possible.

[illegible]
[illegible] October 1968

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WHY ADOLESCENTS KILL THEMSELVES

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Using interviews and psychological tests, the grantee and his associates have compared 50 adolescents after an attempted suicide, with unsuicidal peers of the same age, sex, and background. Although economic privation, broken homes, and disciplinary problems were found in the control group—the sequence and timing of events occurred at a different phase in the development of the child. The profile of the suicidal adolescent includes long-standing problems with family, a stage of escalation during adolescence, a final stage of alienation—a chain reaction that dissolves the adolescent's closest personal bonds. Given detailed biographical knowledge of an adolescent, this study indicates that it should be possible to pick out the youth in danger, for adolescent suicide is not irrational but over-determined by sequences of life events occurring in critical periods.

> "'Tis because of us children, too, isn't it, that you can't get a good lodging?"
>
> "Well, people do object to children sometimes."
>
> "Then if children make so much trouble, why do people have 'em?"
>
> "Oh, because it is a law of nature."
>
> "But we don't ask to be born?"
>
> * * * "I wish I hadn't been born."
>
> "He got up and went away into the closet adjoining her room in which a bed had been spread on the floor. There she heard him say, 'If we children were gone ther'd be no trouble at all!'" * * *
>
> "At the back of the door were fixed two hooks for hanging garments, and from these the forms of the two youngest children were suspended by a piece of box-cord round each of their necks, while from a nail a few yards off the body of little Jude was hanging in a similar manner."
>
> —JUDE THE OBSCURE, *Thomas Hardy.*

Background

Adolescent suicide is horrifying, unthinkable, and a little unreal to most adults, for we tend to be complacent about the troubles of the young. To the modern adults, *Romeo and Juliet* may seem only a story. Yet many adolescents cling to one another in similar love, with the desperation of a last hope in a lonely world. A modern Juliet is likely to be a frightened and pregnant little girl: the boy is likely to be rejected, and both may feel totally alone.

Literary descriptions of childhood suicide seem bizarre, yet they resemble modern case histories. In Thomas Hardy's *Jude the Obscure*, the restless wanderings and misery of unmarried parents overcome an unwanted oldest boy. When he hears that yet another unwanted baby is coming, he kills himself and the other children. It is not that such events don't happen, but we are reluctant to believe them.

In 1965, Jacobziner estimated that there were 60,000 attempted suicides among young people under age 20 in the United States each year. Adolescence can be a particularly lonely and difficult period, a time of biological upheaval and social change. A person is expected to emerge from the safety and dependency of childhood into responsible maturity. Even healthy and happy adolescents become moody and oscillate between passions and depressions in a manner that the older people around them rarely understand. Most adolescents have fantasies about killing themselves in moments of rage and frustration or when they feel totally isolated from their families and friends. This is not surprising. Who has not imagined, with some glee, the remorse his parents would feel if he killed himself? Between such imaginings and the act lies the world of pathological events that Doctor Teicher and his associates have begun to define.

Statistics portray great misery among a large population of adolescents. Suicide ranks as the fourth most frequent cause of death for young people 15–19 years old. Fortunately, the vast number of attempted suicides in this age group are thwarted. An estimate of 60,000 suicide attempts a year may seem exaggerated, but hospital admissions offer a convincingly sad picture. In 1960, for instance, at New York's Bellevue Hospital attempted suicide was the reason for admitting 10 percent of the child and adolescent patients. At Kings County Hospital in Brooklyn, 13 out of every 100 children who came to the hospital had attempted or threatened suicide. Each month, the huge Los Angeles County-U.S.C. Medical Center admits about seven patients between 14 and 18 who have attempted to kill themselves; over 80 a year.

The Attempted Suicides

There has been a general tendency to dismiss a suicide attempt in an adolescent as an impulsive act stemming from a temporary crisis or depression. Perhaps it is soothing to believe that someone so young with "life ahead of him" could not have intended to kill himself. He could not have considered that he might die. On the contrary, Doctor Teicher and his associates at the Medical Center of the University of Southern California have found many adolescents who attempted to take their lives more than once. At first they may have used the drastic move as a threat to draw attention to their problems. Instead, it generally made matters worse. After an escalation of long standing problems and loss of any meaningful relations, many concluded that death was really the only solution to unsolvable, unbearable, and chronic problems.

Beginning with Freud around 1920, many keen minds in the development of psychiatry have wrestled with the problem of adolescent suicide, but inferences drawn from a few cases or psychological studies did not indicate how to predict a suicide from outside circumstances. In the fall of 1964, the investigator and his associates began to study the life situations of adolescents who attempted suicide, comparing them with control adolescents matched for age, race, sex, and family income—control adolescents who had never attempted suicide. Quite a few interesting patterns have been drawn from this study of 50 young people who attempted suicide. All were between 14 and 18. None of them was mentally retarded or obviously pregnant. All had been brought into the Los Angeles County-U.S.C. Medical Center sometime between September 1964 and May 1965 because of their suicide attempt.

At least one parent, usually the mother, was studied as well. For comparison there was a control group of 32 youngsters and their parents. Three-quarters of the attempted suicides were girls. On the average the suicidal adolescents were around 16 years old. They were white, Mexican, Negro, Protestant, Catholic, and Jewish.

Procedure: Cha of Life Events

The procedure called for an interview with the adolescent patient within 24 to 48 hours after the suicide attempt. The parent or parents were also interviewed. Then the suicidal youngster's therapy sessions in the hospital were taped and transcribed for further analysis.

Two biographies were elicited from structured interviews. There was the parent's version of his child's history, and there was the adolescent's version of his own life. On the basis of the case histories,

a life history chart was constructed for each suicide attempter and his matched control. This was done by constructing a chronology (in parallel) on a vertical continuum that depicted all the experiences of the adolescent from birth until the suicide attempt. These graphic charts show residential moves, school changes, the beginnings of various behavioral problems, separation, divorce, or remarriage of the parents, and deaths in the family. The charts were put in a sequence that displayed how the events tended to pile up at a particular point in the adolescent's life. This indicated how the crises had accumulated during the adolescent's life.

What events distinguished those who attempted suicide from those who did not? A simple comparison of events in the lives of the control group and the suicide attempters might not show that there was a very pronounced difference. The investigators discerned a distinct process leading to progressively deeper unhappiness and pessimism. The suicide-attempters went through a sequence that led to progressive isolation from the important people in his life. The control adolescents did not. The process can be summarized in three stages: The suicide-attempters all had a long-standing history of problems from childhood into adolescence. There was also a period in which problems seemed to escalate, usually at the very beginning of adolescence. Moreover, the problems mounted in a manner that seemed to exceed those of peers and friends. Finally, came a phase characterized by a "chain reaction dissolution of any remaining meaningful social relationships." This isolation occurred in the days and weeks preceding the suicide attempt.

Sequential Analysis of Life Events

The advantage of looking at things sequentially can be demonstrated by comparing the two groups. For instance, the life histories of the suicide-attempters showed that 72 percent of them came from broken homes, yet 53 percent of the control group also came from broken homes. Former studies of suicide have emphasized the fact that there were more broken homes among suicide attempters than "control" adolescents. However, none of these studies examined the broken homes of comparison groups. If one looked only at the incidence of broken homes and severed parental relations, there is no great difference between suicidal youths and comparable nonsuicidal youths. However, by looking at the chronological biographies of these two groups, the grantees have seen that the relevance of a broken home depends upon *when* the instability occurred in the child's development.

Critical Phase

Although 72 percent of the suicide attempters and 53 percent of the control adolescents came from broken homes, the timing of divorce and remarriage was different. In the suicidal group 58 percent of the parents remarried, but only one-fourth of the control parents remarried. Moreover, these control parents managed to remarry very early in the child's life and remained married. The parents of the suicidal adolescent either remarried quite a bit later in his life, or, if they remarried early, they were subsequently divorced and remarried several times again.

The chronological mapping of biographies shows that the suicidal adolescents had parents who were divorced, separated, or remarried after the onset of adolescence. By contrast, the control families experienced change earlier, if at all. Instability in the home apparently had a differential effect depending upon the age of the child. Both groups experienced the instability of a broken home, but the nonsuicidal adolescents had a stable homelife during their last 5 years, while the suicidal youths had experienced instability then. As the investigators have written,[1]

> "This is particularly significant, not only because divorce, separation, or the acquisition of a stepparent is stressful and disruptive event per se, but also because it occurs during a particularly stressful life time in the life cycle, i.e., adolescence."

A great many people who have written about suicide have implied that the loss of a parent in childhood might cause depression and perhaps suicidal feelings later in life. This study would not bear out such a conclusion, since the control group also experienced parental loss in childhood. Perhaps it is not loss of a parent in childhood that predisposes a person to depression and suicide in later life. Loss of a love object, as the grantee has remarked, is an important aspect of the process. But loss must be viewed as a part of the process, and particular attention must be paid to the time when it occurred. Most of the adolescents began their maelstrom descent toward suicide after a long period of alienation from parents. One 14-year-old who had tried to commit suicide twice was asked why. She replied, "It's my mother."[2]

> Asked what her mother did, she answered, "We just don't get along. We haven't for 3 years. Before that we were like sisters and then it seems like since she divorced my stepfather it started a lot of trouble."

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[1] Jacobs, J., and Teicher, J. D. Broken homes and social isolation in attempted suicides of adolescents. "*International Journal of Social Psychiatry*," 13(2) : 146, 1967.

[2] Unpublished transcript.

This girl enjoyed being in the hospital and did not want to return home. It is particularly poignant that she wanted to be committed to a State mental hospital rather than return home. Many of the young suicide attempters described their alienation from parents as a process in which either the mother or father would nag them, would cut them off from their friends, would disapprove of their favorite friends, and thus made it difficult for them to have relationships outside the home, at the same time making life very difficult for them within the home. This was their version.

The Broken Romance

Typically, many of these adolescents had fallen in love and formed very possessive and exclusive romantic relationships. This actually isolated them even more. A girl and boy would concentrate so intensely on one another that they tended to cut off all their friends. Then, if the romance failed, they would feel hopeless, lost and despairing.

At the time of the interviews none of the adolescents in the control group was ending a romance, but a number of the "suicidal adolescents" had just broken a romance. Moreover, five of these girls were either pregnant or feared that they were pregnant. As the biographies revealed, pregnancy inevitably led to a great sense of isolation. These girls withdrew and were rejected by their boyfriends. Usually, they were also rejected by their parents at this time when they most needed support. The suicidal adolescents were really in a state of depression compared with their counterparts, and, indeed, as the grantees point out, this seemed to have been prompted by their real experiences in life.

The Way They Saw It

Only 3 percent of the suicidal youngsters considered their childhood to have been happy. But about 94 percent of the control group considered childhood to have been a happy time for them. In describing the biographies, the investigators wrote:[8]

> "Judging from the verbatim accounts of the suicide-attempters in the interviews as well as the suicide notes left by them, and notes written by other adolescents outside our sample, the decision to suicide was the result of a rational, decision-making process. However, the choice of death is not based on a desire to die. They would, if they could, choose to live. Death, in a sense, is not chosen at all but results from the progressive failure of adaptive techniques to cope with the problems of living, where "the problem"

[8] Jacobs, J., and Teicher, J. D. Broken homes and social isolation in attempted suicides of adolescents. *"International Journal of Social Psychiatry,"* 13(2) : 148, 1967.

is the maintenance of meaningful social relationships. In short, the potential suicide felt he had no choice, i.e., death was necessary. It is from this recognition of necessity that the sense of relief stems and immediately preceding the act itself there is often a feeling of well-being, a cessation of all cares. This is evidenced in the matter-of-fact presentation found in suicide notes.

Problem of Problems: Disruption at Home and Discipline

Early in childhood or adolescence the suicidal youngsters usually experienced the break-up of their home. In some cases this meant the institutionalization of the child or a family member. Many of them were placed in foster homes or left with relatives. Many of them changed schools and residences frequently. Many of these families were very poor. In some cases, the parents also had been depressed and had attempted suicide. A sizable percent of the suicidal youngsters had either a parent, relative, or close friend who had attempted suicide. Seventy-two percent had one or both of their natural parents away from home, either because of divorce, separation, or death. Most of those living with stepparents felt they didn't like the stepparent. A great many had a parent who was married several times. In about 62 percent of the cases both parents were working. Half of these families lived on less than $3,600 per year. The background is one of poverty, instability, and unhappiness.

The specific period just preceding a suicide is characterized by a vicious spiral of events. It may begin when a parent feels unable to cope with some behavior in his or her adolescent. The parent begins to nag and use severe disciplinary procedures to prevent the youngster from going out. He may resort to physical punishment. Parents of the suicidal adolescents felt that their children would get into less trouble if they were watched more closely. Therefore, they would question them about their activities and whereabouts. Because the adolescent's trust in his parent somehow depended upon dignity and the maintenance of a certain amount of privacy, questioning set up a vicious circle of mistrust. From the point of view of the adolescents (as revealed on a rating scale), withholding privileges, fussing, nagging, and whipping were considered the worst disciplinary techniques. The suicidal adolescents and their nonsuicidal counterparts agreed on this rating. At the same time, some of the adolescents felt they would gladly forego undesirable behavior, and their parents should have helped them to discourage this behavior. When the parents didn't intervene, the young people took it as a sign of rejection.

As the parent-child situation got worse, the parents grew frustrated, and the adolescent felt that his parents couldn't understand and were punishing him inappropriately. The biographies revealed that this impasse led to the adolescent's rebellion or withdrawl. This stage of

deterioration usually led to a breakdown of communication between parent and child, in which the youth's withdrawal was a consequence. Essentially, both parent and adolescent would give up and stop trying to communicate.

Many suicidal adolescents said that they got into the habit of lying and would simply withdraw into their rooms, or withdraw into themselves in order to avoid their parents and conflict.

School

A third of the adolescents who had attempted suicide were out of school at the time. Either they were ill because of pregnancy or because of an earlier suicide attempt. An astonishing number had already attempted suicide in the past. A quarter of these suicidal adolescents had been out of school because they were acting up in class, had shown some emotional instability, or had been involved in fights. Half of them had been truant from school during the last 5 years because of lack of interest or active distaste.

To Whom Do You Turn in Time of Trouble?

When asked to whom they turned when they were in trouble, a quarter of the suicidal adolescents said there was no one to turn to. None of the control adolescents felt such isolation. The pathos and the loneliness of the suicidal adolescent is very dramatically shown in some of the figures. Of the 46 percent who reported their suicide attempt to other people, less than half reported it to their parents. Almost two-thirds of them talked to people other than family members. This is particularly significant since 88 percent of the suicide attempts occurred at home, very often with the parents in the next room. In every instance, the lack of communication between family and the child and lack of communication with peers was a very important factor in the period leading to suicide. On interview, these suicidal adolescents conveyed the despairing sense that death was the only solution, there was no other way out. Consider these excerpts from a letter by a 17-year-old Negro boy to his father. This note was written the evening before he made his second suicide attempt:

> "Dear Father, I am addressing you these few lines to let you know that I am fine and everybody else is and I hope you are the same. Daddy, I understand that I let you down and I let Mother down in the same way when I did that little old thing [the suicide attempt] that Wednesday night. Daddy, I am sorry if I really upset you, but Daddy after I got back I realized how sad and bad you felt when I came back to California.—I had lost my best girl the week before I did that. I had a fight because some

dude tried to take advantage of her when I sped to the store, so I came back and I heard a lot of noise like bumping so I run in and there he is trying to rape my girl, my best one too.—Daddy I tried as hard as I could to make it cheerful, but it does get sad. Daddy I am up by myself. I've been up all night trying to write you something to cheer you up, because I could see your heart breaking when you first asked Sam's wife if they would have room and that Sunday Dad, it was hard but I fought the tears that burned my eyes as we drove off and Daddy part of my sickness when I had taken an overdose I did just want to sleep myself away because I missed you Dad.

"But when I left I felt like I had killed something inside of you and I knew you hated to see me go, and I hated to go, but Daddy, well, I kind of missed Mother after I had seen her. I miss you and remember what you said, 'settle down', but Daddy I tried so hard so I went and bought some sleeping pills and took them so both of you could feel the same thing." [4]

When an adolescent has retreated from family problems into a love affair, and then the romance breaks up or culminates in pregnancy, then there is even more isolation than before. A girl is especially alone if her boyfriend disappears and she has already alienated other friends. Parents often become disillusioned and give up at the time their child needs help the most. In a letter to her former boyfriend, a desperate young girl showed the lengths to which she would go for a social relationship and a solution to the problem of pregnancy. She wrote on the night of a suicide attempt. A short excerpt indicates the tragic sense of rejection and isolation.

"Dear Bill, I want you and I to get an understanding about certain things because I think you got the wrong impression of me * * * and believe me it hurt. I knew all the time you were hinting to me I was too young, didn't know nothing about life, but you were wrong. I know a whole lot about life. I'm ashamed of the things I know to be so young. I couldn't tell you this personally, 'cuz I couldn't face what you might have said and I sure it would have hurt my feelings badly. I'm two months pregnant by you. You don't have to admit it, I don't care. You may say anything you like. You don't have to worry about any trouble. It would be a disgrace for me to let people know I threw myself on you knowing you didn't care or feel anyway toward me. Don't worry, no one will ever know my child's father. I will never mention you to him or her whichever it be." [5]

Parents and Physicians: Surprised

Despite the history of increasing problems, the families were inevitably hurt and surprised by the suicide attempt. Parents and physicians who had seen the adolescents would say "it was so unexpected."

[4] Teicher, J. D., and Jacobs, J. Adolescents who attempt suicide: Preliminary findings. *American Journal of Psychiatry*, 122(11) : 5, May 1966.

[5] Teicher, J. D., and Jacobs, J. Adolescents who attempt suicide. "*American Journal of Psychiatry*," 122(11), 1966.

Actually, some 46 percent of the suicide-attempters had visited their physicians at some time before the attempt. Over half had been treated for some physical or mental disturbance during the prior 5 years. A third had some serious physical complaint, and a third of them had some family member who was sick or had been hospitalized. In screening the adolescents to be included in this study, Doctor Teicher and his associates examined over 100. In the first 30 they found 11 with duodenal ulcers.

In spite of the long history of problems, however, the physician and mothers acted surprised by the suicide attempts. While perhaps expressing some guilt, the mothers would deny that there was anything in the home situation that would cause a suicide. The very people who were closest to the suicide-attempters apparently failed to see the progression of social isolation: the problems with parents, with poverty, broken romances, excommunication from school or peers, especially in the instance of pregnancy. Since these are problems that most people would be reticent to discuss with others, adolescents in such predicaments are especially isolated.

After a period of not communicating, their first suicide attempt came as a surprise to parents, friends, and schoolmates. The physicians who saw them just after the attempt had been taken off guard perhaps because suicidal people are not easily distinguished from others with severe problems. There seem to be no simple and convenient ways of anticipating a suicidal attempt. No litmus test can determine who is a potential suicide. Clearly a major reason that suicidal attempts are not warded off is lack of communication of the real feelings. The true biography of the unhappy person was not known by anybody around him.

Profiles for Prevention

Adolescence is a time of sufficient duress for parents and youngsters as new behavioral problems arise. Moreover, many of the suicidal youngsters in the Los Angeles study also had illness or mental illness in their family during the preceding 5 years. Doctor Teicher and his associates feel that various sets of events must be considered in anticipating suicide. Among them are such factors as economic status, geographic mobility, and the divorce rate in the home. These alone do not predict suicide. However, these events seem to occur at particular times in the adolescent's life and the timing may be critical. Along with an escalation of behavioral problems, a youth who is isolated from family and peers may be in danger of trying suicide.

It should not be surprising to learn that their parents also had unhappy histories. The mothers often got married only because they were pregnant. Some had illegitimate children. Quite a few suffered

depression and were depressed after giving birth. This was particularly notable among the mothers of the *boys* who had attempted suicide. Many had illegitimate children or had been forced into marriage because of pregnancy. Seventy percent of them were separated or divorced, a good number of them after short-lived marriages of convenience. Needless to say, a huge percentage had suffered from economic deprivation.

Male Suicide

The number of suicides and suicide attempts among girls far outweighs the number of attempts among boys; and this has been associated with broken romances, rejection, and unwanted pregnancy. In attempting to understand the male suicide attempts, Doctor Teicher and Dr. N. L. Margolin did a special study of 13 of the boys in their group. They were interviewed by one of the authors after their suicide attempt. Identical questionnaires about parent-child relationships and school, about adjustment to peer groups and career aspirations were given to the boys and their parents. Both took a battery of psychological tests in addition.

The boys in the control group also came from broken homes. Many had both parents working and relatives living with the family. However, the vignettes of the suicidal boys differed in that they showed a repeated sequence of events which the authors summarize in this order: They had, first of all, a mother who was angry, depressed, or withdrawn, both before and after pregnancy. Generally it was an unwanted pregnancy. Then, there was the loss of some very significant person or persons in the patient's early life, usually the loss of the father. There was also a reversal of roles with the mother. At the time of the suicide attempt it had seemed to the boy that the mother (or his mother-surrogate) was also going to leave his life forever. During the boy's period of distress his mother was preoccupied with her own depression, up to the time of her son's suicide attempt.

An 18-year-old Mexican-American boy is typical. His mother never wanted him. She became very overprotective until he was about age 12. At age 5 his semi-alcoholic father left the home. At this point he and his mother began to shift around from house to house, mostly living with his grandmother. After the divorce he began to get headaches. His mother thought he missed his father. He always felt rejected, and he made depressed statements such as: "I wish I hadn't been born." Then at the age of 15 he was rejected by a girl. This left him emotionally fractured. He would get into romances where he was inevitably hurt and depressed. His mother felt she had never been shown any love or affection by her own family, and she was a chronically depressed person. She explained that, as she was getting older,

W[illegible] understanding of the pineal gland help to explain why some [illegible] the nervous system show severe symptoms during certain [illegible] instance, is there a reason why people in temperate cli[illegible] more from ulcers in spring and fall?

[illegible] between pineal secretion and sex hormones may help to [illegible] oddities in medicine, such as of periodic hypertension [illegible] whose abnormal increases in blood pressure occurred like [illegible] every 27 days.

If the secretion of the pineal gland indirectly play a "clocking" [illegible] may in animals, we may begin to ask ourselves [illegible] manipulation of light and dark, whether our schedules of [illegible] and the illumination used during our working [illegible] pervasive if elusive influence upon our moods and [illegible]. Could the manipulation of [illegible] become an important [illegible] preventive and therapeutic medicine? Dr. Edmund Dewan [illegible] suggest that it is possible to entrain ovulation-time in [illegible] the bedroom on certain nights. This implies that [illegible] resembling that of drugs and that it may be [illegible] with.

[illegible] the last two centuries, people in the United States have lived [illegible] proportion of their lives in electric light which is "non-[illegible]" as Doctor Wurtman says. It does not include all the [illegible] of natural light. Electric light may be deficient, a form [illegible] as far as the brain is concerned.

Many [illegible] still remain to be investigated in biological rhythms. [illegible] of the brain do these rhythms originate? What is the [illegible] mechanism that makes many biological phenomena fluctuate [illegible] 24 hours? When these questions are answered, important ad[illegible] medical research will be possible.

[illegible]
[illegible] October 1968

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WHY ADOLESCENTS KILL THEMSELVES

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Using interviews and psychological tests, the grantee and his associates have compared 50 adolescents after an attempted suicide, with unsuicidal peers of the same age, sex, and background. Although economic privation, broken homes, and disciplinary problems were found in the control group—the sequence and timing of events occurred at a different phase in the development of the child. The profile of the suicidal adolescent includes long-standing problems with family, a stage of escalation during adolescence, a final stage of alienation—a chain reaction that dissolves the adolescent's closest personal bonds. Given detailed biographical knowledge of an adolescent, this study indicates that it should be possible to pick out the youth in danger, for adolescent suicide is not irrational but over-determined by sequences of life events occurring in critical periods.

> "'Tis because of us children, too, isn't it, that you can't get a good lodging?"
> "Well, people do object to children sometimes."
> "Then if children make so much trouble, why do people have 'em?"
> "Oh, because it is a law of nature."
> "But we don't ask to be born?"
> * * * "I wish I hadn't been born."
> "He got up and went away into the closet adjoining her room in which a bed had been spread on the floor. There she heard him say, 'If we children were gone ther'd be no trouble at all!'" * * *
> "At the back of the door were fixed two hooks for hanging garments, and from these the forms of the two youngest children were suspended by a piece of box-cord round each of their necks, while from a nail a few yards off the body of little Jude was hanging in a similar manner."
>
> —JUDE THE OBSCURE, *Thomas Hardy.*

Background

Adolescent suicide is horrifying, unthinkable, and a little unreal to most adults, for we tend to be complacent about the troubles of the young. To the modern adults, *Romeo and Juliet* may seem only a story. Yet many adolescents cling to one another in similar love, with the desperation of a last hope in a lonely world. A modern Juliet is likely to be a frightened and pregnant little girl: the boy is likely to be rejected, and both may feel totally alone.

Literary descriptions of childhood suicide seem bizarre, yet they resemble modern case histories. In Thomas Hardy's *Jude the Obscure*, the restless wanderings and misery of unmarried parents overcome an unwanted oldest boy. When he hears that yet another unwanted baby is coming, he kills himself and the other children. It is not that such events don't happen, but we are reluctant to believe them.

In 1965, Jacobziner estimated that there were 60,000 attempted suicides among young people under age 20 in the United States each year. Adolescence can be a particularly lonely and difficult period, a time of biological upheaval and social change. A person is expected to emerge from the safety and dependency of childhood into responsible maturity. Even healthy and happy adolescents become moody and oscillate between passions and depressions in a manner that the older people around them rarely understand. Most adolescents have fantasies about killing themselves in moments of rage and frustration or when they feel totally isolated from their families and friends. This is not surprising. Who has not imagined, with some glee, the remorse his parents would feel if he killed himself? Between such imaginings and the act lies the world of pathological events that Doctor Teicher and his associates have begun to define.

Statistics portray great misery among a large population of adolescents. Suicide ranks as the fourth most frequent cause of death for young people 15–19 years old. Fortunately, the vast number of attempted suicides in this age group are thwarted. An estimate of 60,000 suicide attempts a year may seem exaggerated, but hospital admissions offer a convincingly sad picture. In 1960, for instance, at New York's Bellevue Hospital attempted suicide was the reason for admitting 10 percent of the child and adolescent patients. At Kings County Hospital in Brooklyn, 13 out of every 100 children who came to the hospital had attempted or threatened suicide. Each month, the huge Los Angeles County-U.S.C. Medical Center admits about seven patients between 14 and 18 who have attempted to kill themselves; over 80 a year.

The Attempted Suicides

There has been a general tendency to dismiss a suicide attempt in an adolescent as an impulsive act stemming from a temporary crisis or depression. Perhaps it is soothing to believe that someone so young with "life ahead of him" could not have intended to kill himself. He could not have considered that he might die. On the contrary, Doctor Teicher and his associates at the Medical Center of the University of Southern California have found many adolescents who attempted to take their lives more than once. At first they may have used the drastic move as a threat to draw attention to their problems. Instead, it generally made matters worse. After an escalation of long standing problems and loss of any meaningful relations, many concluded that death was really the only solution to unsolvable, unbearable, and chronic problems.

Beginning with Freud around 1920, many keen minds in the development of psychiatry have wrestled with the problem of adolescent suicide, but inferences drawn from a few cases or psychological studies did not indicate how to predict a suicide from outside circumstances. In the fall of 1964, the investigator and his associates began to study the life situations of adolescents who attempted suicide, comparing them with control adolescents matched for age, race, sex, and family income—control adolescents who had never attempted suicide. Quite a few interesting patterns have been drawn from this study of 50 young people who attempted suicide. All were between 14 and 18. None of them was mentally retarded or obviously pregnant. All had been brought into the Los Angeles County-U.S.C. Medical Center sometime between September 1964 and May 1965 because of their suicide attempt.

At least one parent, usually the mother, was studied as well. For comparison there was a control group of 32 youngsters and their parents. Three-quarters of the attempted suicides were girls. On the average the suicidal adolescents were around 16 years old. They were white, Mexican, Negro, Protestant, Catholic, and Jewish.

Procedure: Cha of Life Events

The procedure called for an interview with the adolescent patient within 24 to 48 hours after the suicide attempt. The parent or parents were also interviewed. Then the suicidal youngster's therapy sessions in the hospital were taped and transcribed for further analysis.

Two biographies were elicited from structured interviews. There was the parent's version of his child's history, and there was the adolescent's version of his own life. On the basis of the case histories,

a life history chart was constructed for each suicide attempter and his matched control. This was done by constructing a chronology (in parallel) on a vertical continuum that depicted all the experiences of the adolescent from birth until the suicide attempt. These graphic charts show residential moves, school changes, the beginnings of various behavioral problems, separation, divorce, or remarriage of the parents, and deaths in the family. The charts were put in a sequence that displayed how the events tended to pile up at a particular point in the adolescent's life. This indicated how the crises had accumulated during the adolescent's life.

What events distinguished those who attempted suicide from those who did not? A simple comparison of events in the lives of the control group and the suicide attempters might not show that there was a very pronounced difference. The investigators discerned a distinct process leading to progressively deeper unhappiness and pessimism. The suicide-attempters went through a sequence that led to progressive isolation from the important people in his life. The control adolescents did not. The process can be summarized in three stages: The suicide-attempters all had a long-standing history of problems from childhood into adolescence. There was also a period in which problems seemed to escalate, usually at the very beginning of adolescence. Moreover, the problems mounted in a manner that seemed to exceed those of peers and friends. Finally, came a phase characterized by a "chain reaction dissolution of any remaining meaningful social relationships." This isolation occurred in the days and weeks preceding the suicide attempt.

Sequential Analysis of Life Events

The advantage of looking at things sequentially can be demonstrated by comparing the two groups. For instance, the life histories of the suicide-attempters showed that 72 percent of them came from broken homes, yet 53 percent of the control group also came from broken homes. Former studies of suicide have emphasized the fact that there were more broken homes among suicide attempters than "control" adolescents. However, none of these studies examined the broken homes of comparison groups. If one looked only at the incidence of broken homes and severed parental relations, there is no great difference between suicidal youths and comparable nonsuicidal youths. However, by looking at the chronological biographies of these two groups, the grantees have seen that the relevance of a broken home depends upon *when* the instability occurred in the child's development.

Critical Phase

Although 72 percent of the suicide attempters and 53 percent of the control adolescents came from broken homes, the timing of divorce and remarriage was different. In the suicidal group 58 percent of the parents remarried, but only one-fourth of the control parents remarried. Moreover, these control parents managed to remarry very early in the child's life and remained married. The parents of the suicidal adolescent either remarried quite a bit later in his life, or, if they remarried early, they were subsequently divorced and remarried several times again.

The chronological mapping of biographies shows that the suicidal adolescents had parents who were divorced, separated, or remarried after the onset of adolescence. By contrast, the control families experienced change earlier, if at all. Instability in the home apparently had a differential effect depending upon the age of the child. Both groups experienced the instability of a broken home, but the nonsuicidal adolescents had a stable homelife during their last 5 years, while the suicidal youths had experienced instability then. As the investigators have written,[1]

> "This is particularly significant, not only because divorce, separation, or the acquisition of a stepparent is stressful and disruptive event per se, but also because it occurs during a particularly stressful life time in the life cycle, i.e., adolescence."

A great many people who have written about suicide have implied that the loss of a parent in childhood might cause depression and perhaps suicidal feelings later in life. This study would not bear out such a conclusion, since the control group also experienced parental loss in childhood. Perhaps it is not loss of a parent in childhood that predisposes a person to depression and suicide in later life. Loss of a love object, as the grantee has remarked, is an important aspect of the process. But loss must be viewed as a part of the process, and particular attention must be paid to the time when it occurred. Most of the adolescents began their maelstrom descent toward suicide after a long period of alienation from parents. One 14-year-old who had tried to commit suicide twice was asked why. She replied, "It's my mother."[2]

> Asked what her mother did, she answered, "We just don't get along. We haven't for 3 years. Before that we were like sisters and then it seems like since she divorced my stepfather it started a lot of trouble."

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[1] Jacobs, J., and Teicher, J. D. Broken homes and social isolation in attempted suicides of adolescents. *"International Journal of Social Psychiatry,"* 13(2) : 146, 1967.

[2] Unpublished transcript.

This girl enjoyed being in the hospital and did not want to return home. It is particularly poignant that she wanted to be committed to a State mental hospital rather than return home. Many of the young suicide attempters described their alienation from parents as a process in which either the mother or father would nag them, would cut them off from their friends, would disapprove of their favorite friends, and thus made it difficult for them to have relationships outside the home, at the same time making life very difficult for them within the home. This was their version.

The Broken Romance

Typically, many of these adolescents had fallen in love and formed very possessive and exclusive romantic relationships. This actually isolated them even more. A girl and boy would concentrate so intensely on one another that they tended to cut off all their friends. Then, if the romance failed, they would feel hopeless, lost and despairing.

At the time of the interviews none of the adolescents in the control group was ending a romance, but a number of the "suicidal adolescents" had just broken a romance. Moreover, five of these girls were either pregnant or feared that they were pregnant. As the biographies revealed, pregnancy inevitably led to a great sense of isolation. These girls withdrew and were rejected by their boyfriends. Usually, they were also rejected by their parents at this time when they most needed support. The suicidal adolescents were really in a state of depression compared with their counterparts, and, indeed, as the grantees point out, this seemed to have been prompted by their real experiences in life.

The Way They Saw It

Only 33 percent of the suicidal youngsters considered their childhood to have been happy. But about 94 percent of the control group considered childhood to have been a happy time for them. In describing the biographies, the investigators wrote:[8]

> "Judging from the verbatim accounts of the suicide-attempters in the interviews as well as the suicide notes left by them, and notes written by other adolescents outside our sample, the decision to suicide was the result of a rational, decision-making process. However, the choice of death is not based on a desire to die. They would, if they could, choose to live. Death, in a sense, is not chosen at all but results from the progressive failure of adaptive techniques to cope with the problems of living, where "the problem"

[8] Jacobs, J., and Teicher, J. D. Broken homes and social isolation in attempted suicides of adolescents. *"International Journal of Social Psychiatry,"* 13(2) : 148, 1967.

is the maintenance of meaningful social relationships. In short, the potential suicide felt he had no choice, i.e., death was the only way. It is from this recognition of necessity that the sense of relief stems and immediately preceding the act itself there is often a feeling of well-being, a cessation of all cares. This is evidenced in the matter-of-fact presentation found in suicide notes.

Profile of Problems: Disruption at Home and Discipline

Early in childhood or adolescence the suicidal youngsters usually experienced the break-up of their home. In some cases this meant the institutionalization of the child or a family member. Many of them were placed in foster homes or left with relatives. Many of them changed schools and residences frequently. Many of these families were very poor. In some cases, the parents also had been depressed and had attempted suicide. A sizable percent of the suicidal youngsters had either a parent, relative, or close friend who had attempted suicide. Seventy-two percent had one or both of their natural parents away from home, either because of divorce, separation, or death. Most of those living with stepparents felt they didn't like the stepparent. A great many had a parent who was married several times. In about 62 percent of the cases both parents were working. Half of these families lived on less than $3,600 per year. The background is one of poverty, instability, and unhappiness.

The specific period just preceding a suicide is characterized by a vicious spiral of events. It may begin when a parent feels unable to cope with some behavior in his or her adolescent. The parent begins to nag and use severe disciplinary procedures to prevent the youngster from going out. He may resort to physical punishment. Parents of the suicidal adolescents felt that their children would get into less trouble if they were watched more closely. Therefore, they would question them about their activities and whereabouts. Because the adolescent's trust in his parent somehow depended upon dignity and the maintenance of a certain amount of privacy, questioning set up a vicious circle of mistrust. From the point of view of the adolescents (as revealed on a rating scale), withholding privileges, fussing, nagging, and whipping were considered the worst disciplinary techniques. The suicidal adolescents and their nonsuicidal counterparts agreed on this rating. At the same time, some of the adolescents felt they would gladly forego undesirable behavior, and their parents should have helped them to discourage this behavior. When the parents didn't intervene, the young people took it as a sign of rejection.

As the parent-child situation got worse, the parents grew frustrated, and the adolescent felt that his parents couldn't understand and were punishing him inappropriately. The biographies revealed that this impasse led to the adolescent's rebellion or withdrawl. This stage of

deterioration usually led to a breakdown of communication between parent and child, in which the youth's withdrawal was a consequence. Essentially, both parent and adolescent would give up and stop trying to communicate.

Many suicidal adolescents said that they got into the habit of lying and would simply withdraw into their rooms, or withdraw into themselves in order to avoid their parents and conflict.

School

A third of the adolescents who had attempted suicide were out of school at the time. Either they were ill because of pregnancy or because of an earlier suicide attempt. An astonishing number had already attempted suicide in the past. A quarter of these suicidal adolescents had been out of school because they were acting up in class, had shown some emotional instability, or had been involved in fights. Half of them had been truant from school during the last 5 years because of lack of interest or active distaste.

To Whom Do You Turn in Time of Trouble?

When asked to whom they turned when they were in trouble, a quarter of the suicidal adolescents said there was no one to turn to. None of the control adolescents felt such isolation. The pathos and the loneliness of the suicidal adolescent is very dramatically shown in some of the figures. Of the 46 percent who reported their suicide attempt to other people, less than half reported it to their parents. Almost two-thirds of them talked to people other than family members. This is particularly significant since 88 percent of the suicide attempts occurred at home, very often with the parents in the next room. In every instance, the lack of communication between family and the child and lack of communication with peers was a very important factor in the period leading to suicide. On interview, these suicidal adolescents conveyed the despairing sense that death was the only solution, there was no other way out. Consider these excerpts from a letter by a 17-year-old Negro boy to his father. This note was written the evening before he made his second suicide attempt:

> "Dear Father, I am addressing you these few lines to let you know that I am fine and everybody else is and I hope you are the same. Daddy, I understand that I let you down and I let Mother down in the same way when I did that little old thing [the suicide attempt] that Wednesday night. Daddy, I am sorry if I really upset you, but Daddy after I got back I realized how sad and bad you felt when I came back to California.—I had lost my best girl the week before I did that. I had a fight because some

dude tried to take advantage of her when I sped to the store, so I came back and I heard a lot of noise like bumping so I run in and there he is trying to rape my girl, my best one too.—Daddy I tried as hard as I could to make it cheerful, but it does get sad. Daddy I am up by myself. I've been up all night trying to write you something to cheer you up, because I could see your heart breaking when you first asked Sam's wife if they would have room and that Sunday Dad, it was hard but I fought the tears that burned my eyes as we drove off and Daddy part of my sickness when I had taken an overdose I did just want to sleep myself away because I missed you Dad.

"But when I left I felt like I had killed something inside of you and I knew you hated to see me go, and I hated to go, but Daddy, well, I kind of missed Mother after I had seen her. I miss you and remember what you said, 'settle down', but Daddy I tried so hard so I went and bought some sleeping pills and took them so both of you could feel the same thing." [4]

When an adolescent has retreated from family problems into a love affair, and then the romance breaks up or culminates in pregnancy, then there is even more isolation than before. A girl is especially alone if her boyfriend disappears and she has already alienated other friends. Parents often become disillusioned and give up at the time their child needs help the most. In a letter to her former boyfriend, a desperate young girl showed the lengths to which she would go for a social relationship and a solution to the problem of pregnancy. She wrote on the night of a suicide attempt. A short excerpt indicates the tragic sense of rejection and isolation.

"Dear Bill, I want you and I to get an understanding about certain things because I think you got the wrong impression of me * * * and believe me it hurt. I knew all the time you were hinting to me I was too young, didn't know nothing about life, but you were wrong. I know a whole lot about life. I'm ashamed of the things I know to be so young. I couldn't tell you this personally, 'cuz I couldn't face what you might have said and I sure it would have hurt my feelings badly. I'm two months pregnant by you. You don't have to admit it, I don't care. You may say anything you like. You don't have to worry about any trouble. It would be a disgrace for me to let people know I threw myself on you knowing you didn't care or feel anyway toward me. Don't worry, no one will ever know my child's father. I will never mention you to him or her whichever it be." [5]

Parents and Physicians: Surprised

Despite the history of increasing problems, the families were inevitably hurt and surprised by the suicide attempt. Parents and physicians who had seen the adolescents would say "it was so unexpected."

[4] Teicher, J. D., and Jacobs, J. Adolescents who attempt suicide: Preliminary findings. *American Journal of Psychiatry*, 122(11) : 5, May 1966.

[5] Teicher, J. D., and Jacobs, J. Adolescents who attempt suicide. "*American Journal of Psychiatry*," 122(11), 1966.

Actually, some 46 percent of the suicide-attempters had visited their physicians at some time before the attempt. Over half had been treated for some physical or mental disturbance during the prior 5 years. A third had some serious physical complaint, and a third of them had some family member who was sick or had been hospitalized. In screening the adolescents to be included in this study, Doctor Teicher and his associates examined over 100. In the first 30 they found 11 with duodenal ulcers.

In spite of the long history of problems, however, the physician and mothers acted surprised by the suicide attempts. While perhaps expressing some guilt, the mothers would deny that there was anything in the home situation that would cause a suicide. The very people who were closest to the suicide-attempters apparently failed to see the progression of social isolation: the problems with parents, with poverty, broken romances, excommunication from school or peers, especially in the instance of pregnancy. Since these are problems that most people would be reticent to discuss with others, adolescents in such predicaments are especially isolated.

After a period of not communicating, their first suicide attempt came as a surprise to parents, friends, and schoolmates. The physicians who saw them just after the attempt had been taken off guard perhaps because suicidal people are not easily distinguished from others with severe problems. There seem to be no simple and convenient ways of anticipating a suicidal attempt. No litmus test can determine who is a potential suicide. Clearly a major reason that suicidal attempts are not warded off is lack of communication of the real feelings. The true biography of the unhappy person was not known by anybody around him.

Profiles for Prevention

Adolescence is a time of sufficient duress for parents and youngsters as new behavioral problems arise. Moreover, many of the suicidal youngsters in the Los Angeles study also had illness or mental illness in their family during the preceding 5 years. Doctor Teicher and his associates feel that various sets of events must be considered in anticipating suicide. Among them are such factors as economic status, geographic mobility, and the divorce rate in the home. These alone do not predict suicide. However, these events seem to occur at particular times in the adolescent's life and the timing may be critical. Along with an escalation of behavioral problems, a youth who is isolated from family and peers may be in danger of trying suicide.

It should not be surprising to learn that their parents also had unhappy histories. The mothers often got married only because they were pregnant. Some had illegitimate children. Quite a few suffered

depression and were depressed after giving birth. This was particularly notable among the mothers of the *boys* who had attempted suicide. Many had illegitimate children or had been forced into marriage because of pregnancy. Seventy percent of them were separated or divorced, a good number of them after short-lived marriages of convenience. Needless to say, a huge percentage had suffered from economic deprivation.

Male Suicide

The number of suicides and suicide attempts among girls far outweighs the number of attempts among boys; and this has been associated with broken romances, rejection, and unwanted pregnancy. In attempting to understand the male suicide attempts, Doctor Teicher and Dr. N. L. Margolin did a special study of 13 of the boys in their group. They were interviewed by one of the authors after their suicide attempt. Identical questionnaires about parent-child relationships and school, about adjustment to peer groups and career aspirations were given to the boys and their parents. Both took a battery of psychological tests in addition.

The boys in the control group also came from broken homes. Many had both parents working and relatives living with the family. However, the vignettes of the suicidal boys differed in that they showed a repeated sequence of events which the authors summarize in this order: They had, first of all, a mother who was angry, depressed, or withdrawn, both before and after pregnancy. Generally it was an unwanted pregnancy. Then, there was the loss of some very significant person or persons in the patient's early life, usually the loss of the father. There was also a reversal of roles with the mother. At the time of the suicide attempt it had seemed to the boy that the mother (or his mother-surrogate) was also going to leave his life forever. During the boy's period of distress his mother was preoccupied with her own depression, up to the time of her son's suicide attempt.

An 18-year-old Mexican-American boy is typical. His mother never wanted him. She became very overprotective until he was about age 12. At age 5 his semi-alcoholic father left the home. At this point he and his mother began to shift around from house to house, mostly living with his grandmother. After the divorce he began to get headaches. His mother thought he missed his father. He always felt rejected, and he made depressed statements such as: "I wish I hadn't been born." Then at the age of 15 he was rejected by a girl. This left him emotionally fractured. He would get into romances where he was inevitably hurt and depressed. His mother felt she had never been shown any love or affection by her own family, and she was a chronically depressed person. She explained that, as she was getting older,